W. B. No. 7[illegible]

U. S. DEPARTMENT OF AGRICULTURE
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CHARLES F. MARVIN, Chief

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VOLUME 49, No. 11

NOVEMBER, 1921

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1922

The Weather Bureau desires that the MONTHLY WEATHER REVIEW shall be a medium of publication for contributions within its field, but the publication of contributions is not to be construed as official approval of the views expressed.

ECONOMIES IN PRINTING.

Contributions intended for publication in the REVIEW must in all cases conform to the regulations of the Department of Agriculture with respect to effecting economies in the public printing. The following memorandum in regard to preparing manuscripts for publication has just been issued by the Department.

It is reproduced below for the information of all concerned:

Authors will be expected to prepare their manuscripts, with the understanding that once the manuscript leaves the author's hands it is in final form and not subject to further changes of text in galley or page proof. With the adoption of this policy it will be necessary that authors consult workers on related subjects in other Bureaus before finally submitting their manuscript for publication, and all matters as to which there is difference of opinion must be settled in advance.

BACK NUMBERS OF THE REVIEW WANTED.

The Weather Bureau has not enough of the following numbers of the MONTHLY WEATHER REVIEW to meet even urgent requests for filling up files at institutions where the REVIEW is constantly being referred to. The return of any of these or of any 1919 or 1920 issues, especially November, 1919, will be greatly appreciated. An addressed franked slip may be had on application to the Chief, U. S. Weather Bureau, Washington, D. C.

1914: January, February, March, April, September, October, December.
1915: May, June, July, August.
1916: January, August.
1917: June.
1918: February, September.
1919: Any issue, especially November.
1920: Any issue, especially January.
SUPPLEMENT, No. 3.

MONTHLY WEATHER REVIEW

ALFRED J. HENRY, Editor.

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NOVEMBER, 1921.

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SOME CHARACTERISTICS OF UNITED STATES TEMPERATURES.

By ROBERT DEC. WARD.

[Harvard University, Jan. 3, 1922.]

Introduction.—The present is a fitting time to consider anew the essential characteristics of the temperatures of the United States, and this because the material available for study is now more abundant and better standardized than ever before. In the new *Atlas of American Agriculture,* which has been in preparation by the United States Department of Agriculture for some years, there is a division devoted to *Climate.* This climatic portion contains a *Temperature* section, with three subdivisions, dealing, respectively, with *Temperature, Frost and the Growing Season,* and *Sunshine and Wind.* The only portion of the Temperature Section thus far published in complete and final form is that on *Frost and the Growing Season.*[1] The whole subject of frost is here presented with a detail not hitherto attained in any other area of equal size anywhere in the world.[2] Several of the maps and diagrams which are later to be included in the *Sunshine and Wind* section have been given advance publication in the MONTHLY WEATHER REVIEW.[3] But up to the present time none of the other new charts from the *Temperature* section have been published in any form or discussed anywhere. By permission, and through the courtesy of Dr. O. E. Baker, under whose supervision the new *Atlas of American Agriculture* has been prepared, and of Mr. J. B. Kincer, who constructed many of the maps, and by permission of the Chief of the Weather Bureau, the present writer has been able to have sent to him such of the new charts as he desired to examine for the purpose of the accompanying article, and has been given the privilege of redrawing and of reproducing all of these charts. He is under very great obligations to Dr. Baker, not only for allowing the charts to be sent out of Washington, but also for having certain of them specially drawn, and in some cases for having photographs made of the originals.

The whole discussion of temperature for the new Atlas is extraordinarily complete, especially if the size of the area covered is considered. Furthermore, it puts our whole knowledge of temperature conditions in the United States for the first time upon a sound and thoroughly scientific basis. We now have standard temperature charts based upon homogeneous observations covering a uniform period. The unusual completeness of the new discussion may be judged by the list of charts and curves included.[4]

The immediate object of the *Atlas* being to benefit agricultural interests, the needs of that group were primarily in mind in planning the sections on climate. Hence, while all of the maps and curves are of importance, and will prove useful in a variety of investigations, there is naturally considerable detail which is not of immediate significance in a very general discussion like that here in hand. Hence reference is here made to such charts only as have a broad climatic significance. Those who are especially concerned with the more detailed matters of climate and crops will find abundant and most valuable material in the other charts which are listed below (Footnote 4), but are not otherwise referred to in the following discussion.

The larger temperature relations.—The larger facts regarding temperature are best seen on the world isothermal maps which show the course of the (sea-level) isotherms over the oceans as well as over the lands.[5] The isotherms show certain systematic deflections as they pass from ocean to ocean across North America. Thus, in the higher latitudes, there is a marked poleward deflection in the northeastern Pacific, and a more moderate equatorward deflection in northeastern North America. In middle and lower latitudes, *per contra,* there is an equatorward deflection as the isotherms ap-

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[1] *Atlas of American Agriculture.* Prepared under the supervision of O. E. Baker, Agriculturist. Part II. *Climate.* Contribution from the U. S. Weather Bureau, Charles F. Marvin, Chief. Section 1. *Frost and the Growing Season.* By William Gardner Reed, assistant in agricultural geography, Office of Farm Management. Prepared under the joint direction of P. C. Day, climatologist, U. S. Weather Bureau, and O. E. Baker, agriculturist, Office of Farm Management. U. S. Department of Agriculture, Office of Farm Management, W. J. Spillman, Chief. fol. Washington, D. C., 1918 (Advance Sheet, 2). pp. 11, figs. 33.

[2] See R. DeC. Ward: Frost in the United States, *Geogr. Rev.*, vol. 7, 1919, pp. 339-344 (a review of the above).

[3] Joseph Burton Kincer: Sunshine in the United States, Mo. WEATHER REV., vol. 48, 1920, pp. 12-17. Reviewed by R. DeC. Ward: A New Series of Sunshine Maps of the United States, *Geogr. Rev.*, vol. 10, 1920, pp. 339-341.

[4] The following list was contained in a letter from Mr. R. G. Hainsworth, head draftsman, dated Sept. 24, 1921.

Four 24 in. plates. Fig. A, an identification map showing the drainage, culture, and altitudinal tints. Fig. 2 shows the average daily summer temperature. Fig. 72 is a map showing the annual march of significant temperatures at selected stations. Fig. 86 shows, in the form of a graph, the daily minimum and maximum temperatures at selected stations.

Fourteen maps, 7½ by 11¼ inches. Twelve of these show the average monthly temperatures. Fig. 5 shows the average winter temperatures, December to February, inclusive. Fig. 7 shows the average annual minimum temperatures.

Sixty-five maps, 3½ by 5½ inches. Fig. 8 the lowest temperatures ever observed and the number of times in 20 years the lowest temperature was 6° or more below the average temperature; fig. 9, the number of times in 20 years the winter temperature was 9° or more below the average winter temperature; fig. 10, the number of times the maximum temperature was 32° or lower; fig. 11, the average annual number of days with the minimum temperature 32° or lower; fig. 13, the average daily maximum temperature for January; fig. 14, the average minimum temperature for January; fig. 15, the highest monthly mean temperature for January; fig. 16, the lowest mean monthly temperature for January. Corresponding maps are available for the 11 other months of the year.

Fig. 73 shows the average date when the mean daily temperature rises above 35°; fig. 74, the average date when the average daily temperature rises above 45°; fig. 75, the average date when the average daily temperature rises above 55°; fig. 76, the average date when the average daily temperature rises above 65°; fig. 77, the average date when the average daily temperature falls below 65°; fig. 78, the average date when the average daily temperature falls below 55°; fig. 79, the average date when the average daily temperature falls below 45°.

Figs. 81-84 show the mean daily temperature range for January, April, July, and October.

Fig. 1, a graph, shows the annual march of temperature and sunshine by means of monthly curves. An insert graph, fig. 85, shows the daily march of temperature (selected stations). Fig. 87, the last figure in the temperature section, shows graphs of thermograms.

[5] See, e. g., the *Challenger* charts, reproduced in *Atlas of Meteorology*, pls. 1, 3: text, pp. 7, 9.

proach the continent from the Pacific; a poleward looping as they enter the continent, and then another gentle equatorward trend as they approach the Atlantic. These deflections, similar to, but more marked than, those found in corresponding latitudes of Eurasia, result in a crowding of the isotherms on the eastern coasts of the northern continents, and a spreading apart on the eastern sides of the northern oceans. The opposite sides of the North Atlantic show this contrast at its best. "In western Europe, one may travel a thousand miles northward without finding so great a change of mean annual temperature as would be found in a voyage of half that distance along our eastern coast." [6]

These systematic isothermal deflections follow very closely, and are chiefly due to, the general flow of the great ocean currents. The spreading of the isotherms on the west coast of North America depends upon the equatorward-flowing cool return current in the lower latitudes, off the coast of California and of Mexico, and upon the poleward-flowing warm eddy which circles around the Bay of Alaska. On the east coast, the isotherms in the higher latitudes are carried equatorward by the cold Labrador Current, while, farther south, the warm Gulf Stream carries them poleward.

These mean annual sea-level world-isotherms represent approximately the conditions of spring and autumn. Comparing them with those for January and for July, the midwinter and midsummer months, it is seen that in the middle and higher latitudes the mean annual isotherms are a weak reproduction of those of January. In lower latitudes, on the other hand, the systematic deflections of the former resemble those of July. The cold winters of the central and northern interior may thus be said to control the course of the mean annual isotherms over the higher latitudes, while the hot summers of the southern portion of North America leave their mark on the course of the annual isotherms in the lower latitudes.

In comparison with the mean temperatures of the different latitudes, most of North America is too cold in winter (January). A district of abnormally low temperatures (20°–30° F. below the general mean for the latitude) centers over Hudson Bay and the adjacent lands. Another, of abnormally high temperatures (20° F. above the mean of the latitude), appears over the warm waters of the Bay of Alaska. Lying to leeward of this latter district, a considerable strip along the Pacific coast, extending from Alaska to as far south as southern California, is warmer than the means of its latitudes.[7] The isanomalies [8] are less marked in July. North America as a whole is somewhat warmer than the mean temperatures of its latitudes in July. The greatest plus departure (10° or more above normal) occurs over the western interior deserts of Nevada and Arizona. The regions of Hudson Bay and of Labrador, and the Pacific coast, are too cool. In the mean for the year, North America, with the exception of its west coast, is colder than normal for its latitudes.

Mean annual, monthly and seasonal isothermal charts (actual temperatures): General[9]—The fundamental isothermal charts are those for the year, the twelve months, and either the four seasons or the two opposite seasons of summer and winter. With the exception of the mean annual chart, this whole series has been constructed anew, on a uniform basic period, for the *Atlas of American Agriculture*. The new charts show actual temperatures, not reduced to sea-level. They supersede all other existing isothermal maps of the United States, and will, for years to come, remain the "standard set."

Mean annual temperatures.—Certain broad generalizations regarding the distribution of the mean annual temperatures over the United States are readily made.[10] With a wide range of latitude, with two flanking oceans on the east and west, and a warm gulf on the south, it is inevitable that the United States should show considerable differences of temperature between north and south, and between the narrow windward west coast and the interior. Roughly, east of the one hundred and fifth meridian the northern tier of States has 40°–50°; the central tier, 50°–60°; the southern tier, over 60°. The Lake Superior region has below 40°, and southern Florida and southeastern Texas, over 70°. The east-and-west course of the isotherms is modified by the Appalachian mountain system, where the lower temperature, due to elevation, is indicated by the equatorward deflection of the isotherms.

West of the one hundred and fifth meridian the chart is far from satisfactory, owing to the deficiency of observations over the mountains and plateaus. Temperatures over 70° are indicated in southwestern Arizona and southeastern California. Most of the northern portion of the plateau district (north of lat. 38° N.; and, in the southeastern part of the district, as far as lat. 35° N.) has 45°–50°. There is a decrease along the Pacific coast from 65° in the south to 50° in the north. Deflections and irregularities due to topography are especially marked over the southwestern interior. A comparison of the temperatures on the Pacific and the Atlantic coasts shows that these do not differ appreciably in middle and lower latitudes. In the north, however, the Pacific coast is distinctly the warmer. Thus, at latitude 45° on the Pacific, the mean annual temperature is between 50° and 55°; on the Atlantic it is between 40° and 45°. San Diego, Calif., and Charleston, S. C., on the other hand, both in the same latitude, have almost the same mean annual temperatures.

Midwinter and midsummer average temperatures.—The new series of charts showing the average monthly temperatures gives, for the first time, an accurate and detailed picture of the actual distribution of temperatures, month by month, over the United States. The isotherms are drawn for 5° intervals. For roughly two-thirds of the country, to the east of the Rocky Mountains, the isotherms run fairly smoothly and symmetrically, but show the effects of the Appalachian topography in the warping and local irregularities of many of the lines over that section. Over the western plateau and mountain area, on the other hand, there is much irregularity, close crowding, and difficulty in making any broad, accurate generalization. It is for this western area in particular that the

[6] W. M. Davis: Elementary Meteorology, p. 66.

[7] Charles F. Batchelder: A New Series of Isanomalous Temperature Charts, Based on Buchan's Isothermal Charts, *Amer. Met. Journ.*, vol. 10, 1893–94, pp. 451–474. The charts are reproduced in the *Atlas of Meteorology*, pl. 2; text, p. 8.

[8] Departures from the mean temperature of the latitude.

[9] R. DeC. Ward: Bibliographic Notes on the Temperature Charts of the United States. Mo. WEATHER REV., vol. 49, 1921, pp. 277–280. In addition to the publications cited in the foregoing, and in a further paper by the present writer (A Short Bibliography of United States Climatology, *Journ. Geogr.*, vol. 17, 1918, pp. 137–144), reference may here be made to the following publications of the last 15 years which deal with temperature data:

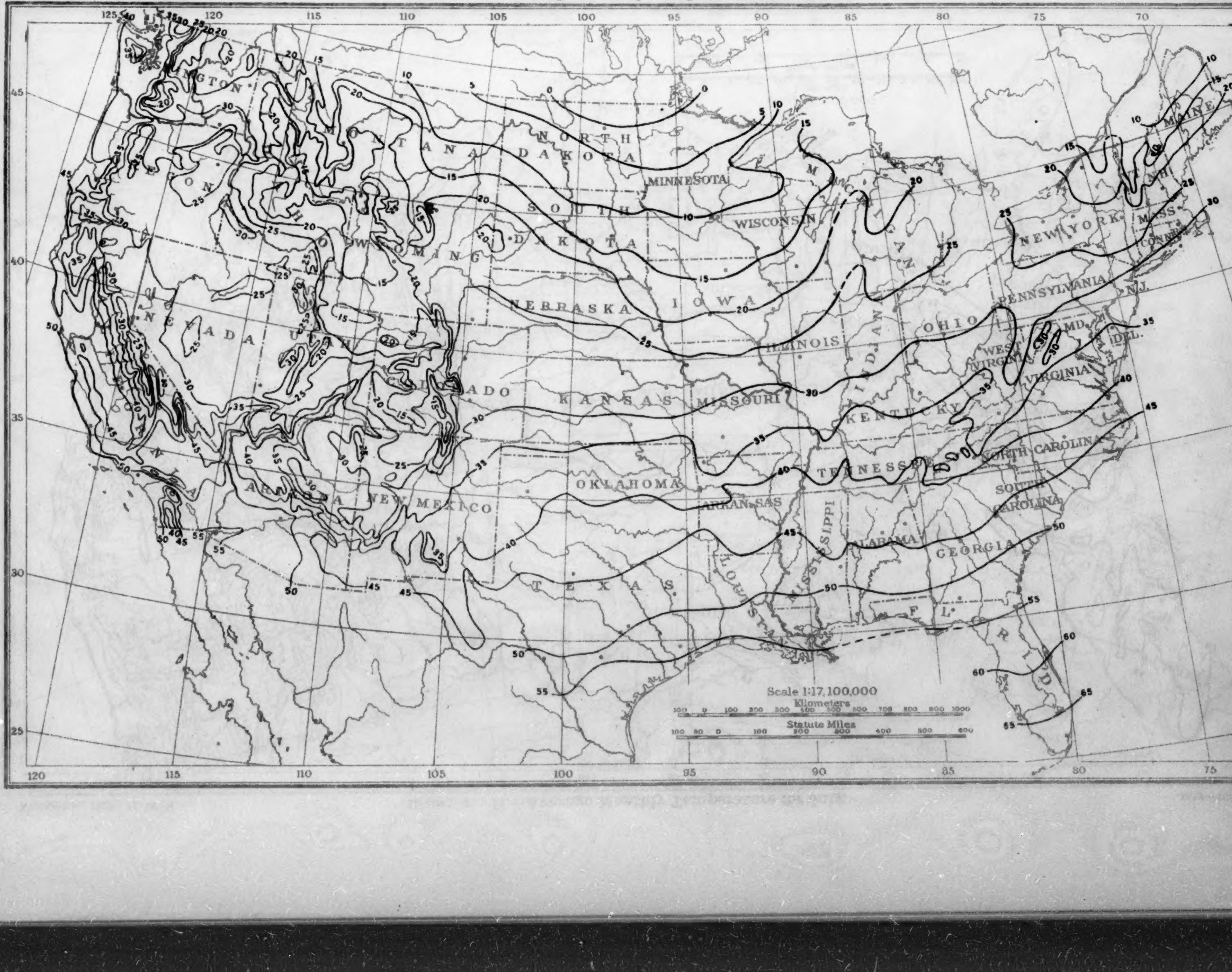
W. B. Stockman: Temperature and Relative Humidity Data, *Bulletin O*, U. S. Weather Bureau. 4to. Washington, D. C., 1905. Contains tables of maximum and minimum temperatures recorded at Weather Bureau stations in each month from the beginning of observations to the end of December, 1904; also the mean monthly and mean annual maximum and minimum temperatures, and charts showing the absolute maxima and absolute minima.

F. H. Bigelow: The Daily Normal Temperature and the Daily Normal Precipitation in the United States. *Bulletin R*, U. S. Weather Bureau. 4to. Washington, D. C., 1908. The daily normals are obtained by a process of smoothing. The monthly means are plotted; a curve is drawn through these twelve points, and the temperatures for each day are then scaled off.

F. H. Bigelow: Report on the Temperatures and Vapor Tensions of the United States. *Bulletin S*, U. S. Weather Bureau. 4to. Washington, D. C., 1909. The statement on the title-page "reduced to a homogeneous system of 24 hourly observations for the 33-year interval 1873–1905" is somewhat misleading. The means are not all reduced to the same period of years. Homogeneous refers only to the reduction to *true* means.

[10] The latest chart of mean annual temperature is that included in the set of *Climatic Charts of the United States* (*U. S. Weather Bureau.*)

I.—Average Monthly Temperature for January.

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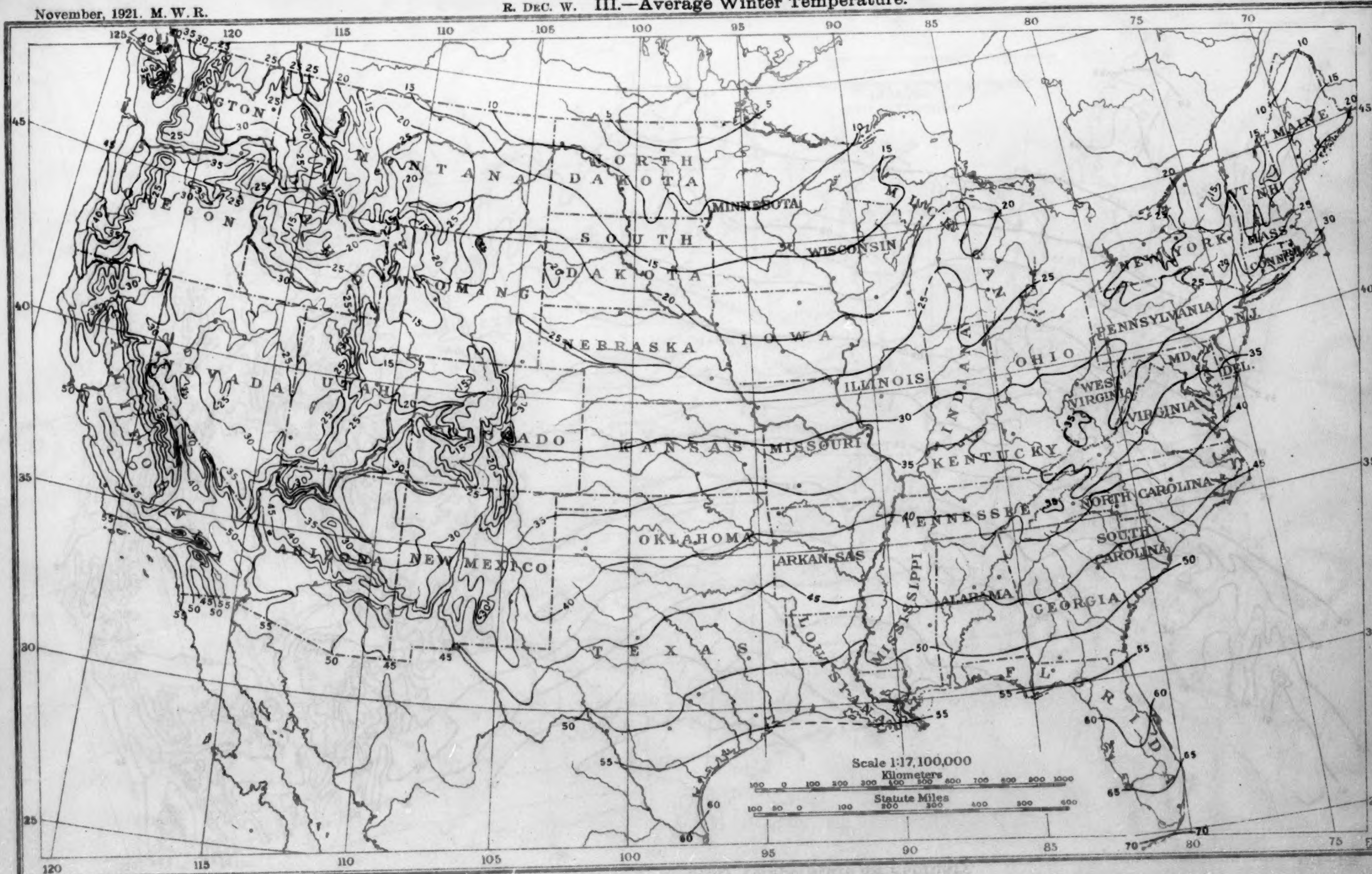
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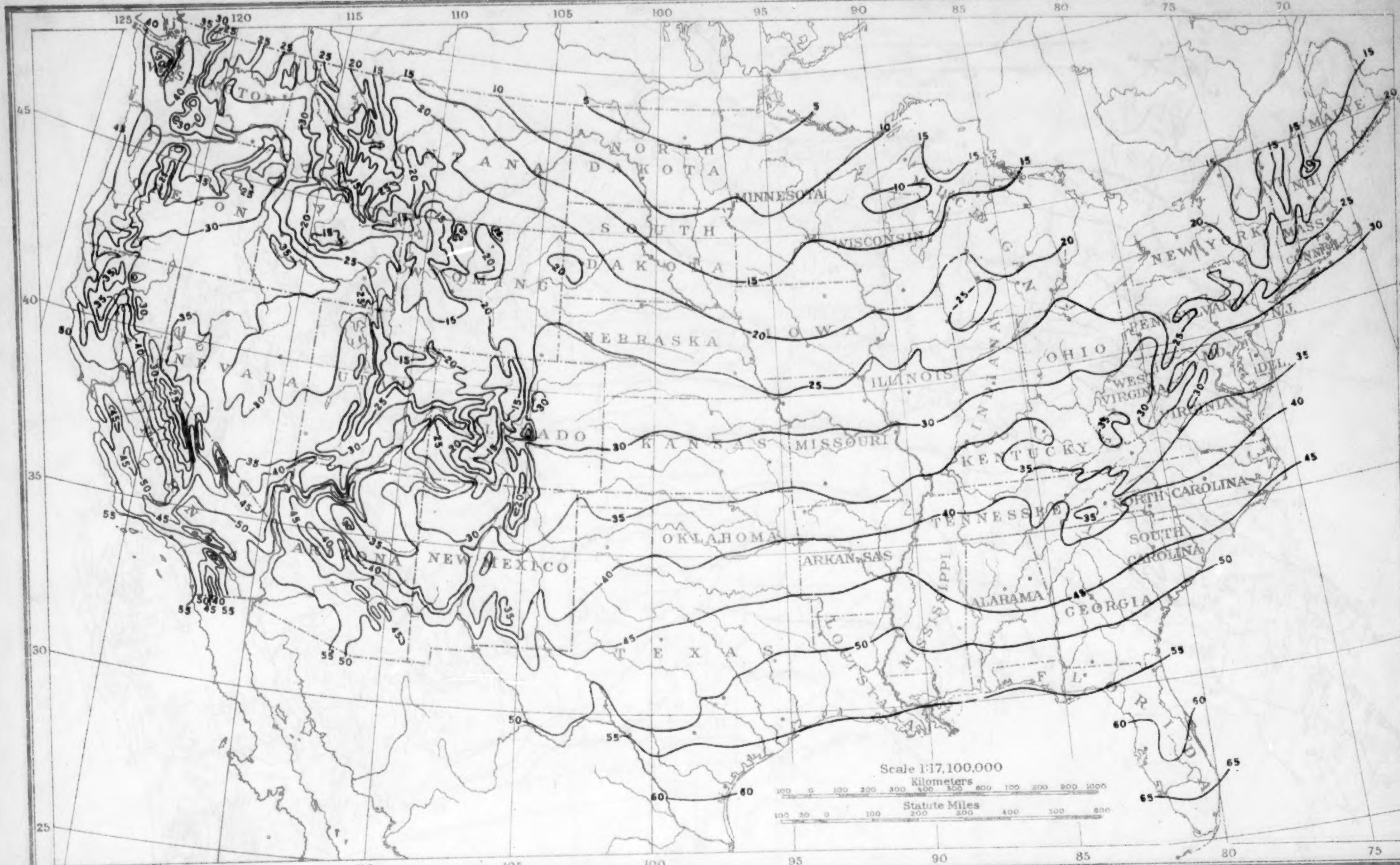
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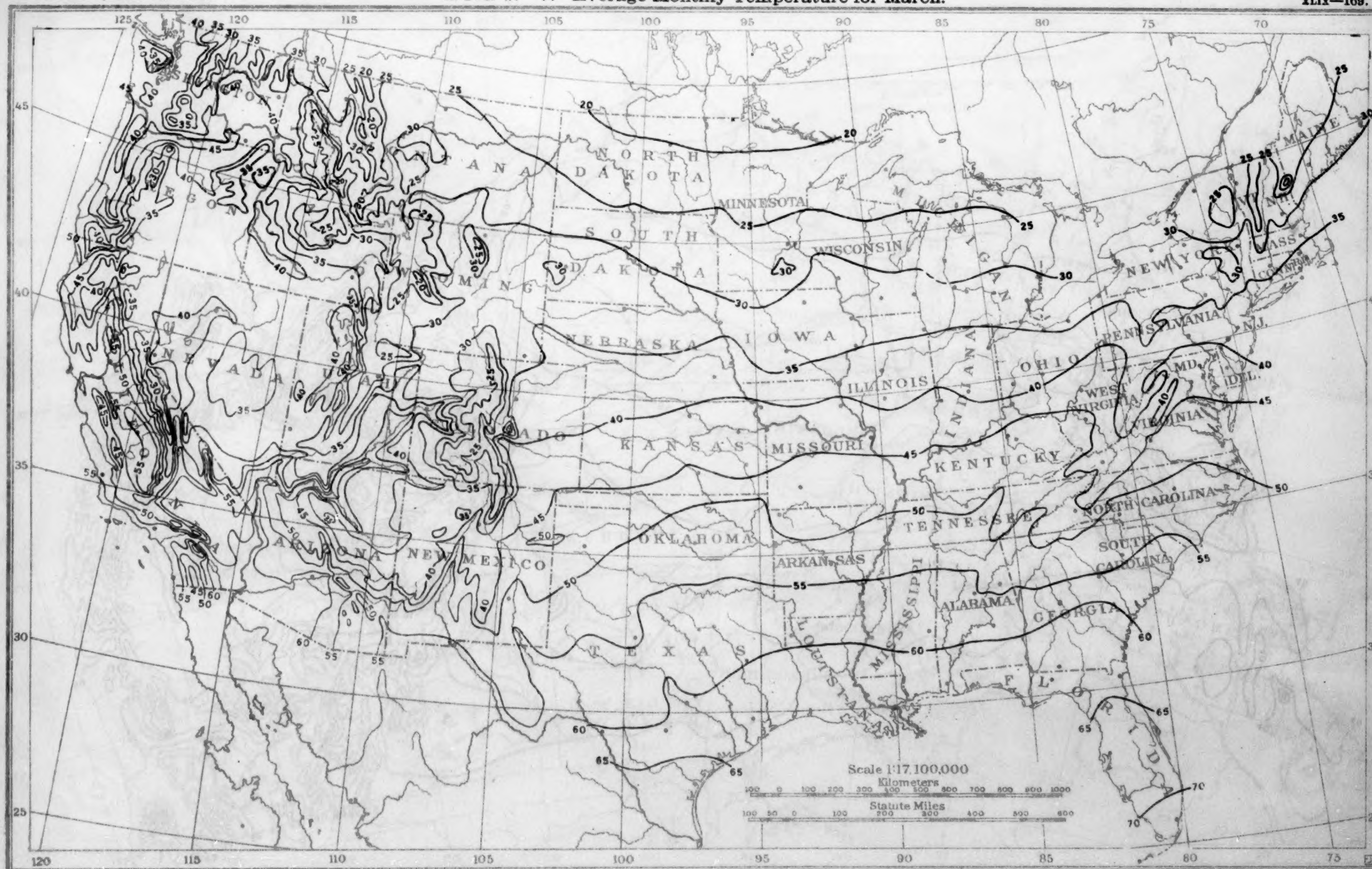
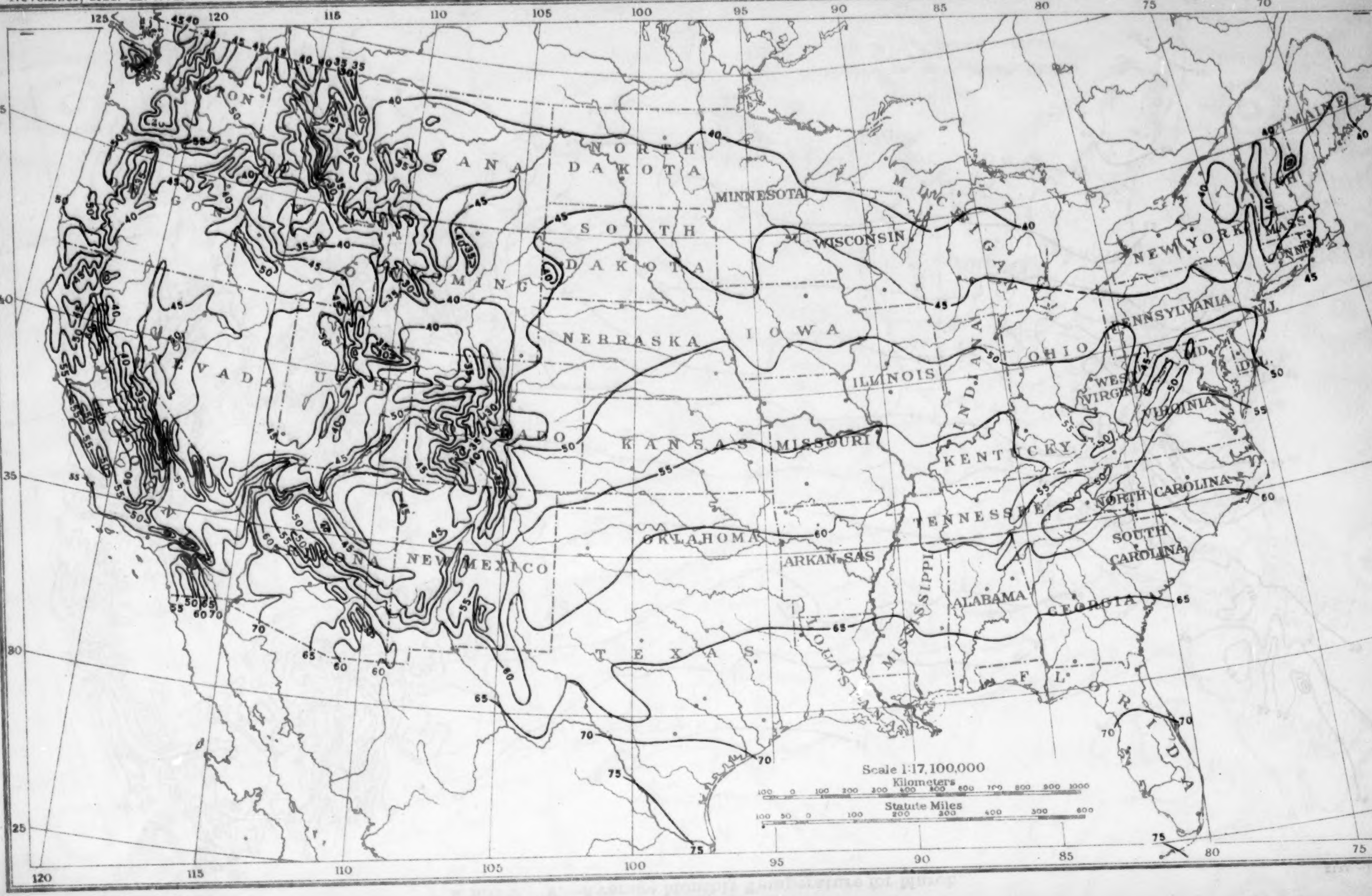
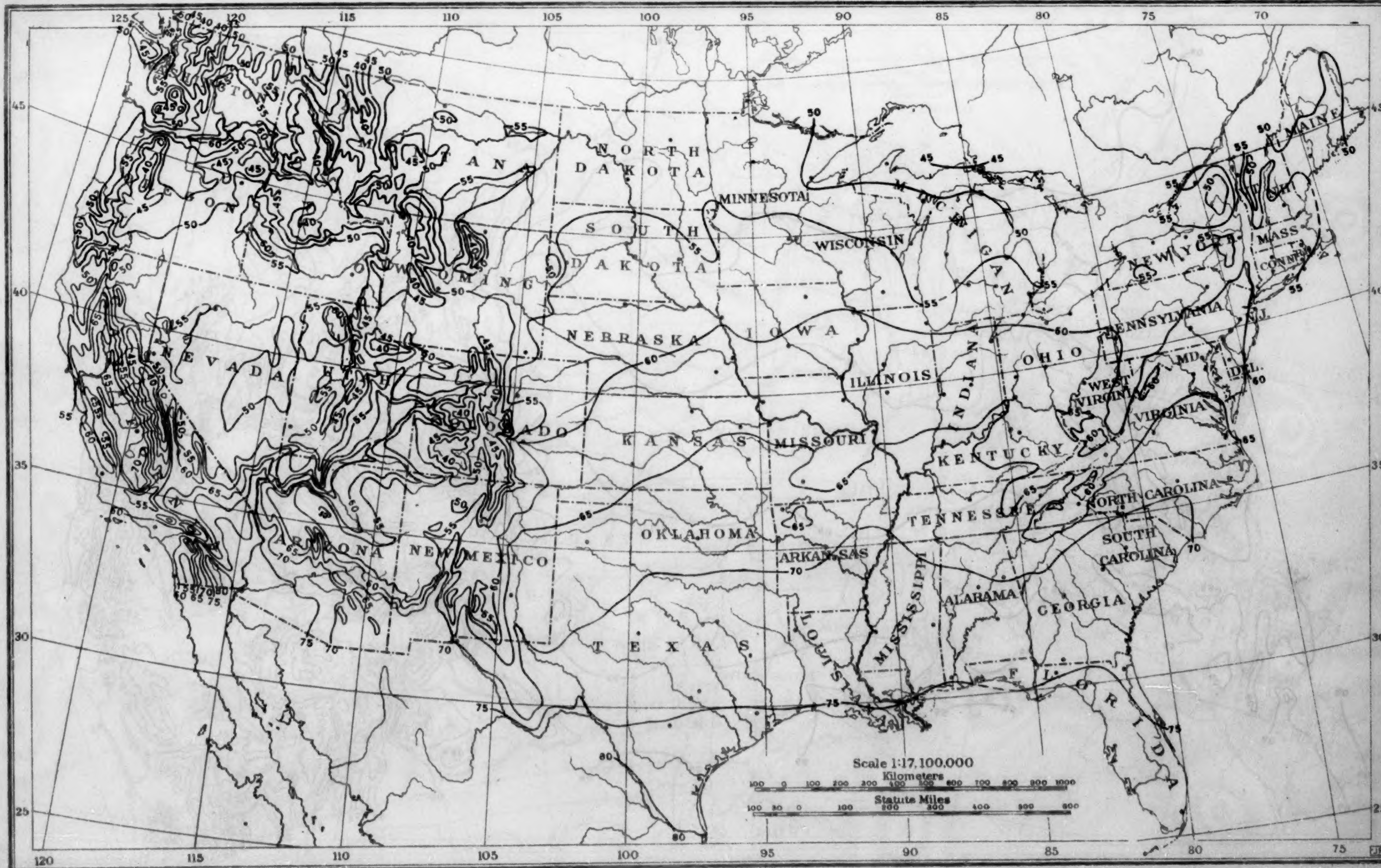
V.—Average Monthly Temperature for March.



VI.—Average Monthly Temperature for April.

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IX.—Average Monthly Temperature for August.

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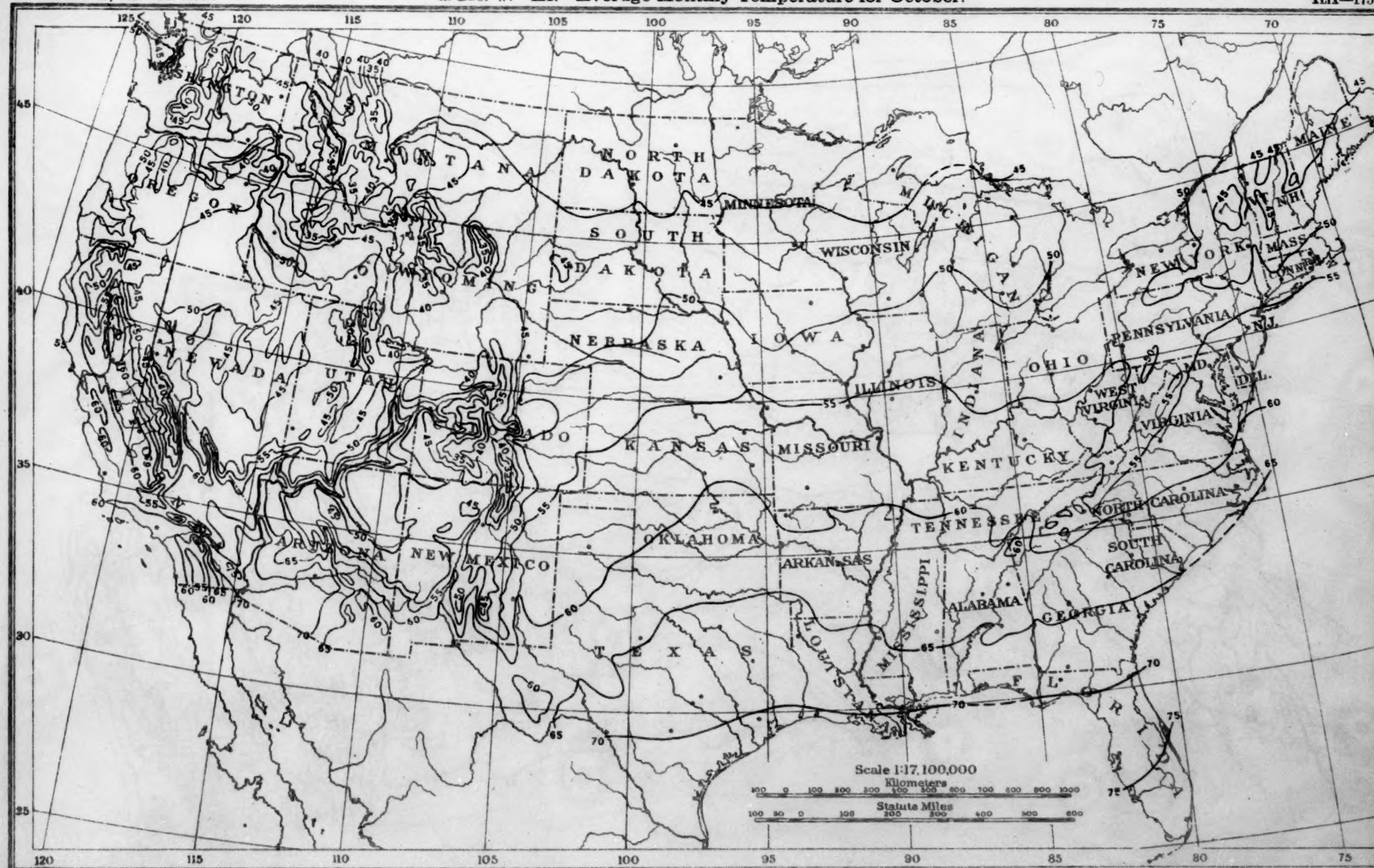
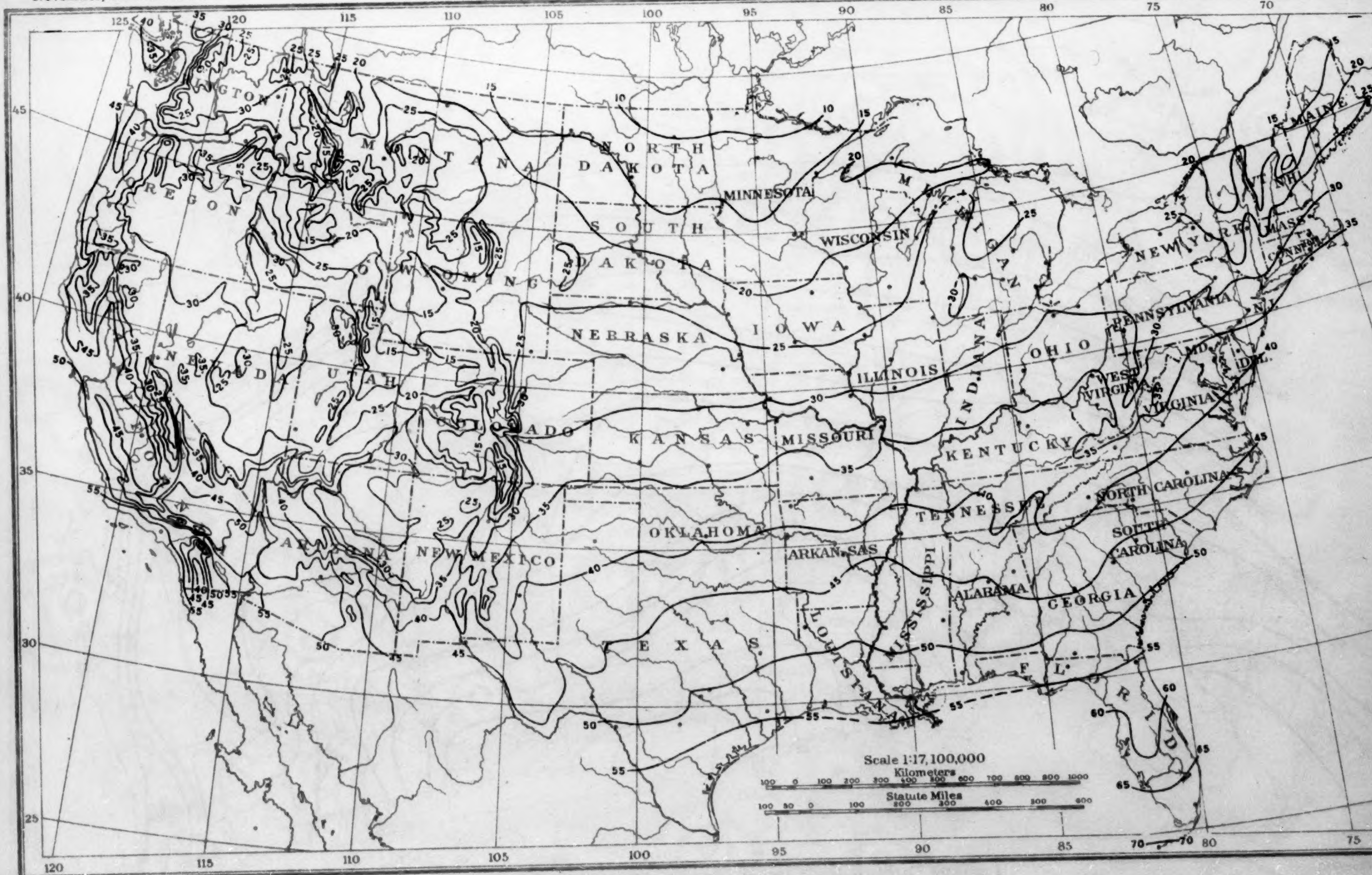
XI.—Average Monthly Temperature for October.

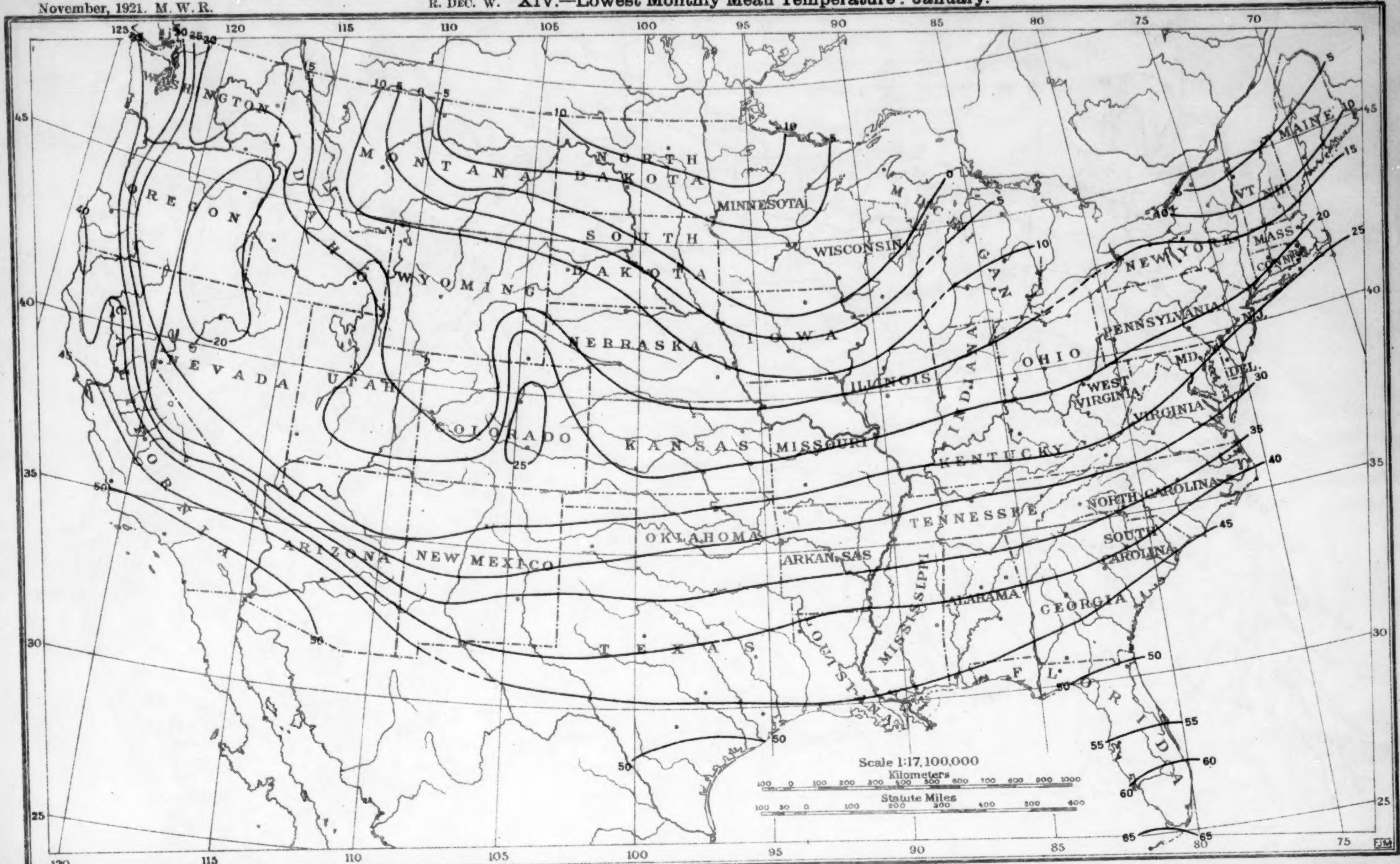


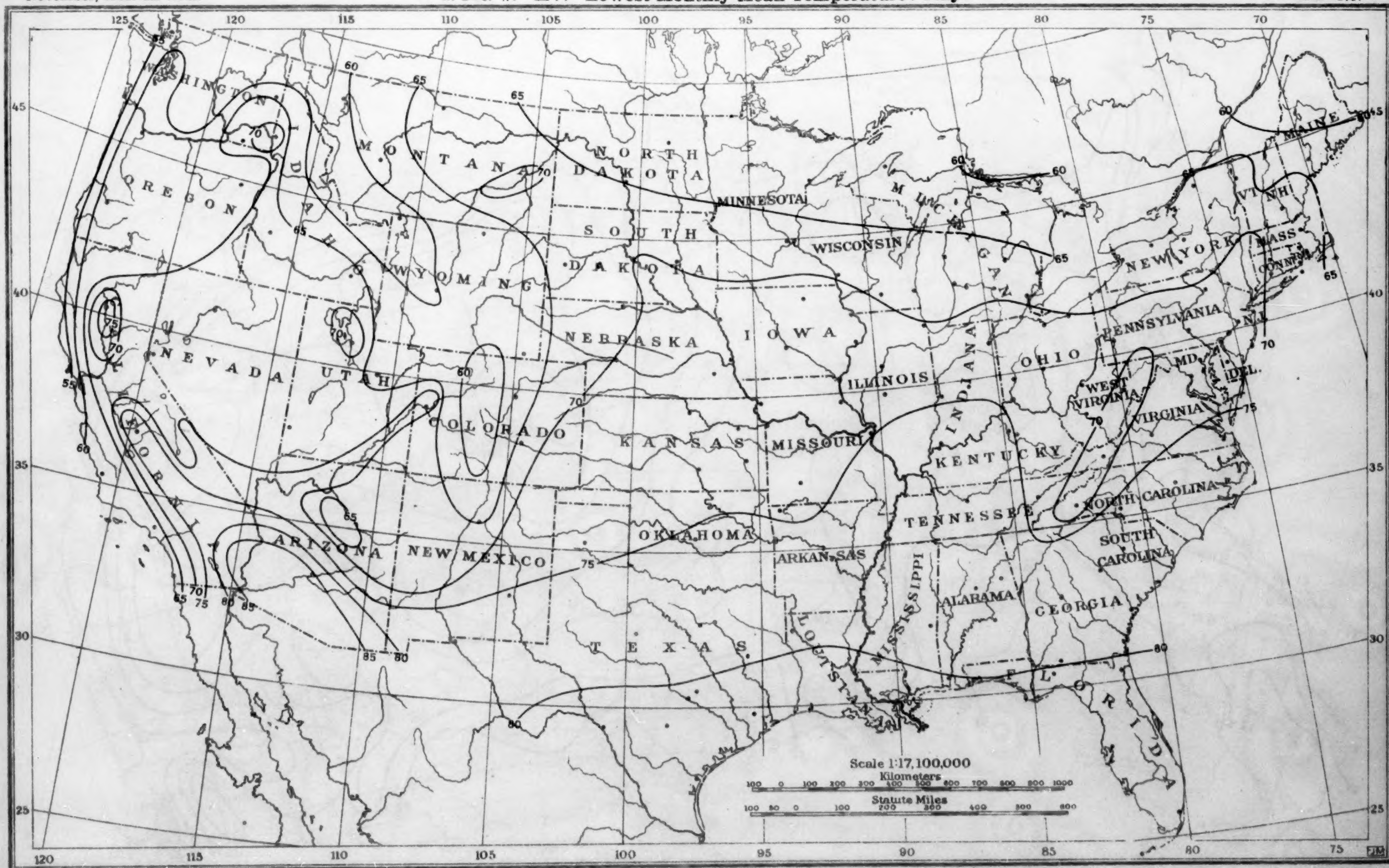
XII.—Average Monthly Temperature for November.

R. DEC. W. XIII.—Average Monthly Temperature for December.



XIV.—Lowest Monthly Mean Temperature: January.

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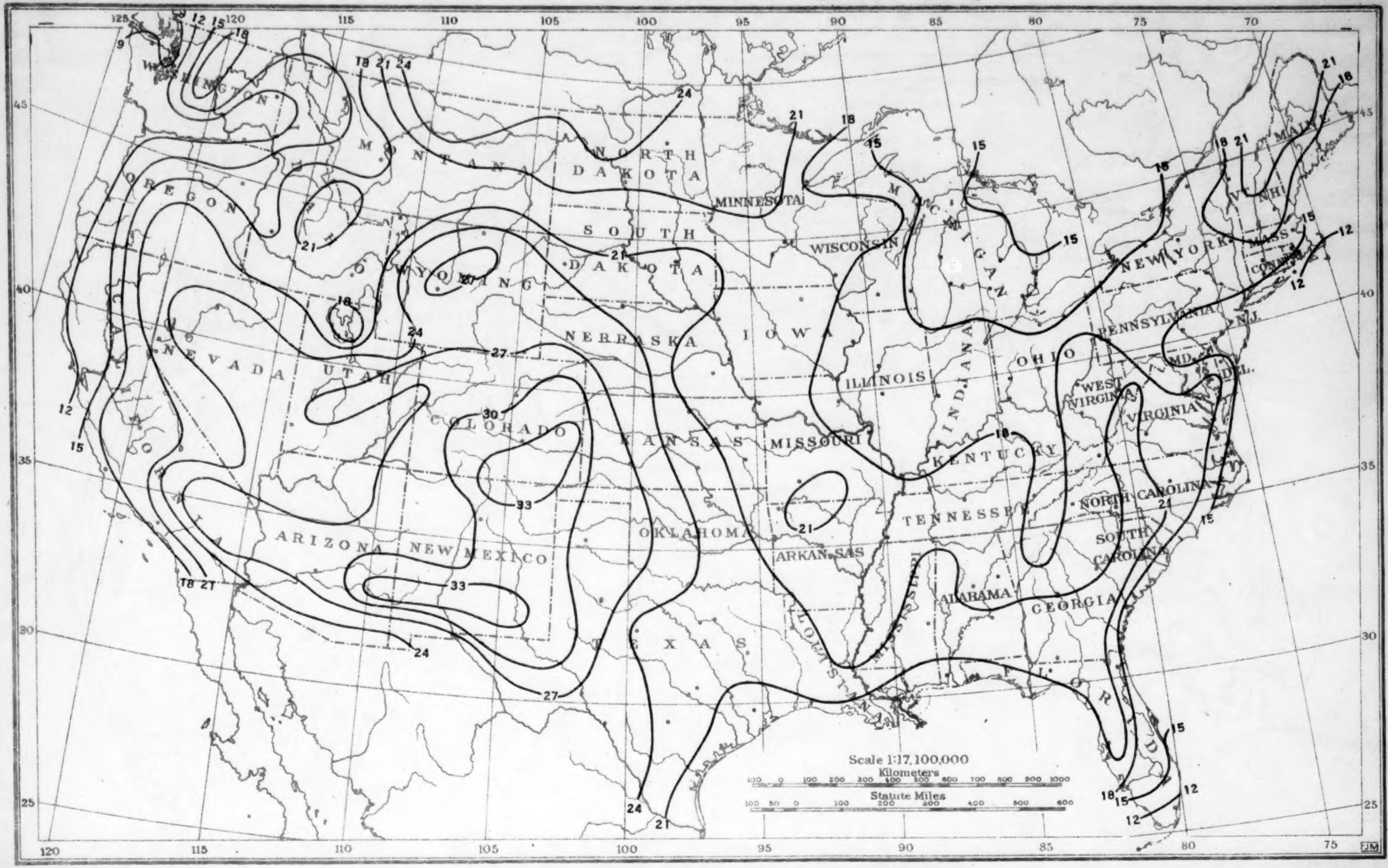
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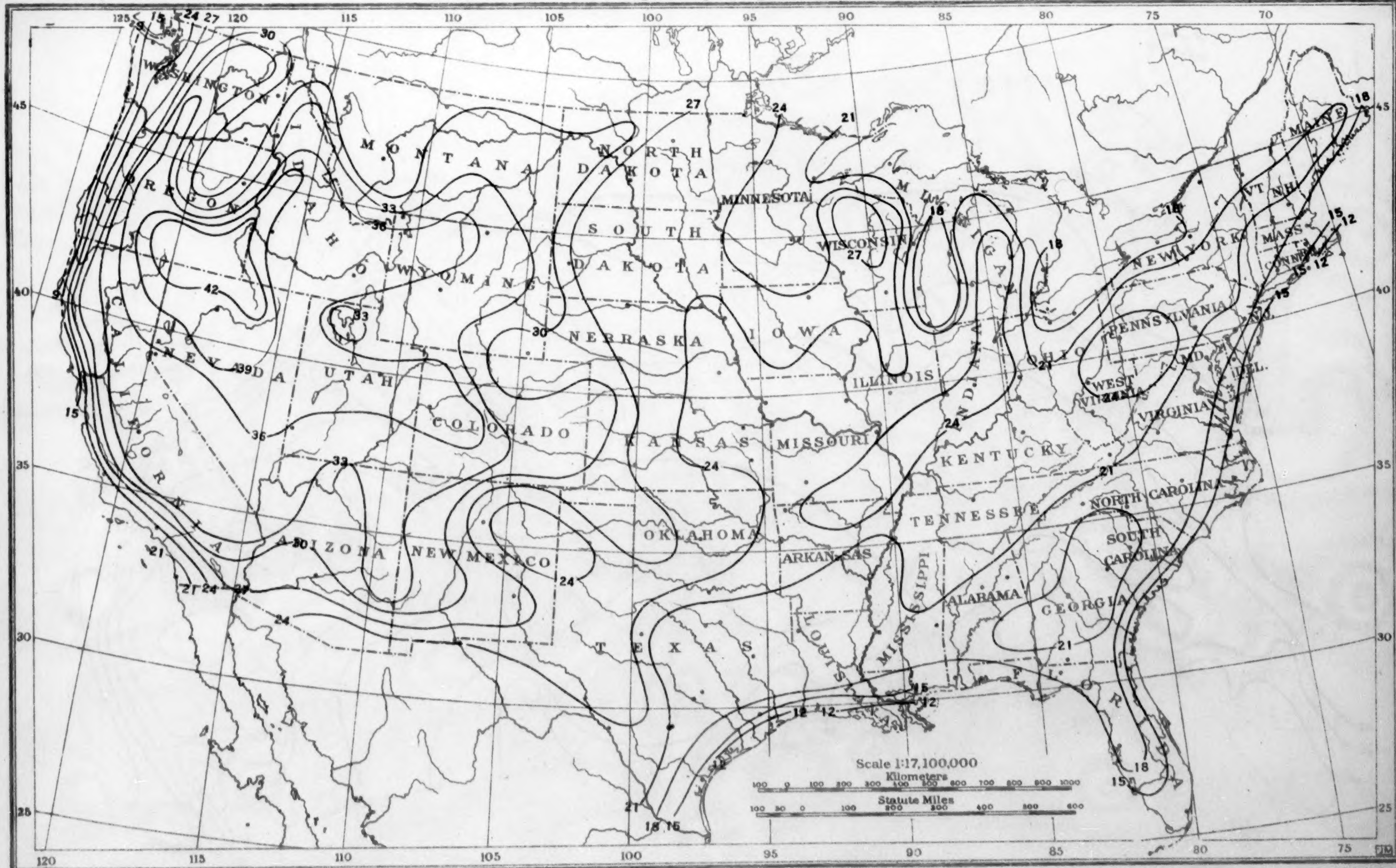
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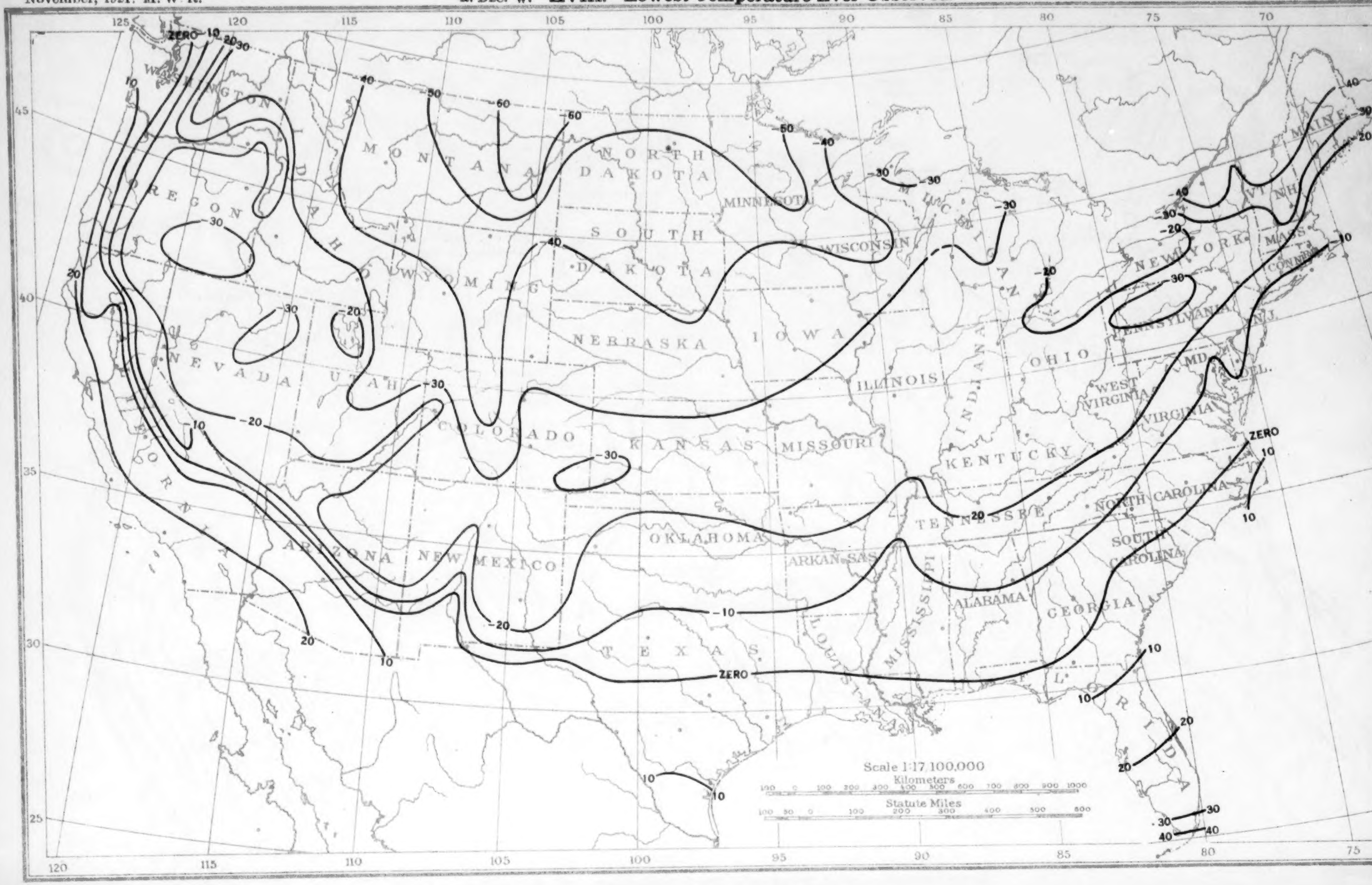
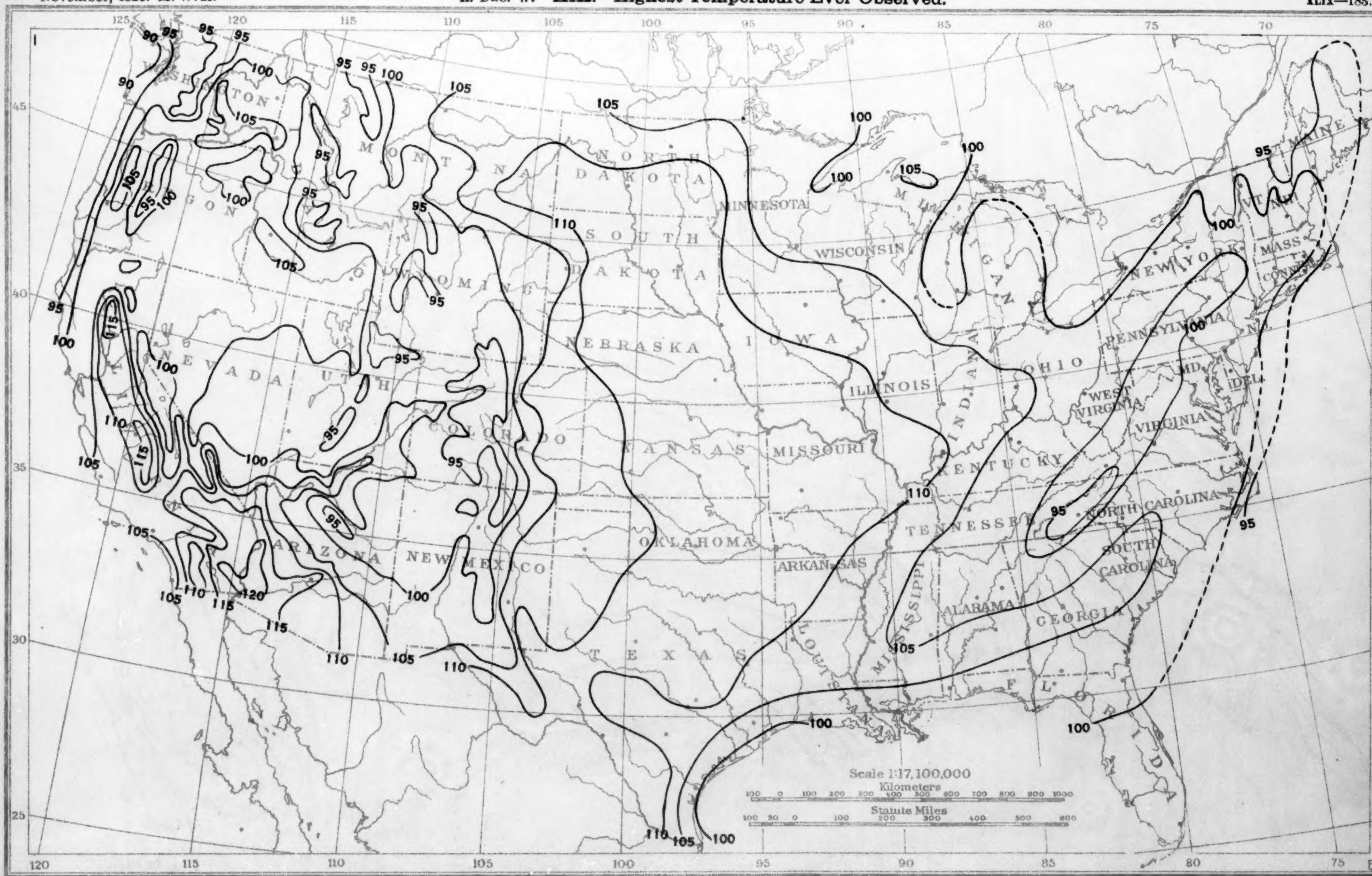
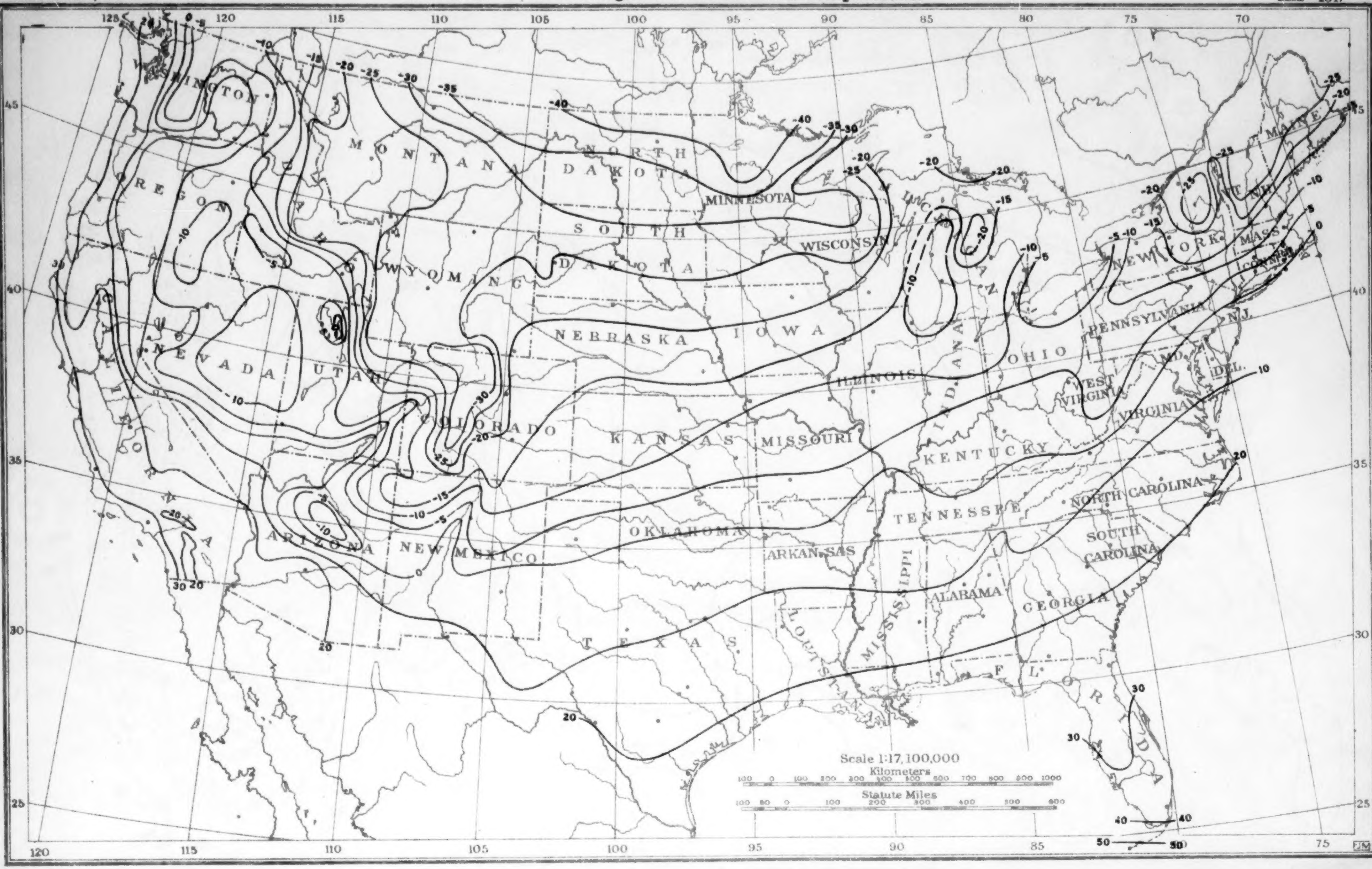
XVIII.—Lowest Temperature Ever Observed.



XIX.—Highest Temperature Ever Observed.



XX.—Average Annual Minimum Temperature.



new charts, which show *actual* temperatures and are constructed with due regard to topographic controls, are such a great advance over all earlier ones.

The greatest differences in temperature between different parts of the United States occur in winter, and it is then that the contrasts between land and water controls are most marked (chart 1). In midwinter (January), the extreme continental effect is seen in the occurrence of mean monthly temperatures of below 10° over the northern interior, between the Great Lakes and the Rocky Mountains, and in northernmost Maine. January means below zero are indicated on the northern border of North Dakota and Minnesota. The equatorward deflection of the isotherms over the northern interior region is a striking feature, which emphasizes, among other things, the fact that the western border of the Great Plains and the eastern foothills of the Rocky Mountains are warmer, in spite of their greater elevation, than the lower-lying country farther east. The general tendency of the eastern and southern isotherms to bend in uniformity with the Atlantic and Gulf coasts shows a tempering effect of the ocean and Gulf waters, which, however, is not very marked owing to the general prevalence of offshore winds. Along the northern shores of the Gulf of Mexico, temperatures of 50°–55° are found. Southern Texas and most of Florida have over 55°. Going south from Duluth to New Orleans, or from the coast of northern Maine to southernmost Florida, the January mean temperatures increase at the rate of about 2.5° for each latitude degree (70 miles). The popularity of southern winter resorts is thus easily explained. Health seekers and "warmth seekers" find the average monthly temperature in January increasing at the rate of about 1.5° for every hour of travel southward in a fast express train. There are two or three areas in the eastern United States where marked local irregularities in the isotherms exist. The northern portion of the Hudson–Lake Champlain depression is clearly indicated as a district of local cold. The central Appalachians show an equatorward warping of the isotherms, and the occurrence of low mean temperatures in certain valleys. A third, and more notable, local irregularity is seen in the Lake region. The moderating influence of the open waters is carried to leeward by the prevailing westerly winds, so that certain stations on the lee shores have somewhat higher winter means than do those on the opposite (windward) shores. The effect is clearly shown in the case of Lake Michigan, where the isotherms of 20° and 25° are bent poleward over the Lake and equatorward again over the lower peninsula of Michigan. The general spreading and warping of all the isotherms in the Lake region is another indication of the local effects due to the Lake waters. Several writers have called attention to this situation.[11] In one of the most recent of these studies, C. H. Eshleman has made a comparison of the temperatures at Grand Haven, Mich., on the eastern shore of Lake Michigan, with those at Milwaukee, Wis., on the opposite (western) shore, and has also compared Grand Haven with a group of inland stations in the same latitude, in Wisconsin, Iowa, and South Dakota. During the colder season, the mean monthly temperatures at Grand Haven run 2°–4° higher than those at Milwaukee, and 5°–8° higher than those at the group of western inland stations.

[11] See, e. g. Alexander Winchell: The Isothermals of the Lake Region. *Proc. Amer. Assoc. Adv. Sci.*, vol. 19, 1870, pp. 106–117; C. Abbe: The Influence of the Lakes on Temperature of the Land, Mo. WEATHER REV., 1900, 28, 343–345; W. F. Cooper: Air and Water Temperatures, ibid., 1905, 33, 521–524; C. H. Eshleman: Climatic Effect of the Great Lakes as Typified at Grand Haven, Mich., *Met'l. Chart of the Great Lakes*, U. S. Weather Bureau, Sept. 1913.

Lorin Blodget, in his now almost forgotten classic, emphasized several of the most striking characteristics of the winter temperature distribution in the United States.[12] He called attention to the occurrence of the lowest winter temperatures to the west of the Great Lakes, "the point of natural minimum" being "broken up by the Lakes" whose location is "most fortunate for the cultivable districts of this part of the United States." He noted the diminished warming effect of the Gulf of Mexico in winter, owing to the "great relative refrigeration of the continent, generally, and the consequent prevalence of land (i. e., offshore) winds," and called attention to similar conditions along the Atlantic coast where, "if the prevalent winds were reversed, the climate would be greatly softened."

In the East, in spite of various irregularities in the isothermal system, the major control over the temperature distribution is obviously latitude. The situation is wholly different over the western mountain and plateau area. Here the isotherms are warped, and crowded or spread apart as the topography may determine. Indeed, even broad generalization is unsatisfactory. A study of the map itself is the only way to gain a good view of the actual situation. It is true that latitude plays a considerable part in determining certain large facts. For example, while the southern deserts of Arizona and southeastern California have January mean temperatures over 50°, the northern plateau, in Washington, has about 20°. But the deserts are of low altitude, while parts of the Washington plateau attain elevations of 1,500–2,000 feet. Beyond these large facts, the temperatures of the mountain and plateau area can not be adequately generalized. Under control of altitude and local topography, supplemented to some extent by latitude, the January isotherms vary from 15° to 55°. Further discussion would lead well into the field of local climatology. It should be observed, however, that the temperatures average higher west of the Rocky Mountains than they do to the east, although the altitudes to the west are greater.

In the Pacific province a very striking feature is the parallelism of the westernmost isotherms with the coast. From north to south there is only a slight increase in temperature. The stations on the coast of southern California, for example, are only a very few degrees warmer than San Francisco, and the extreme northern coast of Washington (40°+) is less than 15° cooler than the extreme southern coast of California (50°+). Latitude is obviously here a very subordinate control, especially when the Pacific coast is compared with the Atlantic. The rate of change of temperature along the entire length of this coast is only about 0.8° per latitude degree, which is less than one-third of the temperature gradient along the Atlantic coast in the same month. Clearly, the prevalence of onshore winds from a relatively warm ocean explains the moderate and noticeably uniform winter temperatures along this coast. Inland, various topographic features are distinctly indicated in the isothermal system. The California Valley, the lower portions of which are inclosed by the 45° isotherm, is contrasted with the lower temperatures of the Sierra Nevada. In southern California, the interior highlands are distinctly cooler than the seacoast. The Valley of Oregon is outlined by its own inclosing isotherms, as is the Columbia River Valley, where the isotherms indicate almost as well as contour lines the gap through the mountains. In Washington, the Olympics and the Cascades are notable features, with

[12] Lorin Blodget: "Climatology of the United States," etc. Philadelphia, 1857.

their lower temperatures as compared with those of the neighboring lower lands. A comparison between the mean January temperatures on the Pacific and on the Atlantic coasts is interesting. The coast of southern California has essentially the same temperatures as have the corresponding latitudes on the southern Atlantic coast. San Francisco is 10°–15° warmer than the corresponding Atlantic coast. The coast of northern Oregon is 20° warmer than the same latitude on the coast of Maine. The excess in favor of the Pacific coast thus increases to the north.

The economic consequences of such winter temperatures as are experienced in the United States are many and varied. Over the cold northern and eastern sections agricultural operations must largely or wholly cease, and there is a general abandonment of outdoor labor except in the case of certain occupations, such as lumbering and ice cutting, which are best, or exclusively, carried on in winter. Transportation conditions are to a considerable extent readjusted. There is difficulty with severe cold and deep snows. The heavy summer vacation travel to the north and east ceases, but is replaced, to an increasing degree, by winter travel to the genial south. The close of navigation on the Great Lakes turns the transportation of freight to the railroads, or leads to a delay in shipments till spring. Many industries show seasonal controls, such as the manufacture of heavy winter clothing, of overshoes, and of rubbers. There is need of heating cars used for the transportation of food which is injured by cold. Even in the case of the shipment of iron ore, for example, as the ore freezes at temperatures somewhat below 32°, precautions must be taken not to have it exposed long at low temperatures. Over the districts of moderate or warm winters, on the other hand, as in the case of the Southern and Pacific Coast States, for example, outdoor and farming operations may continue all winter. The cooler months may, and usually do, bring a change in the character of the outdoor work, but not in its essential nature.

Very different are the conditions in midsummer (chart 2.) The distribution of temperature is far more uniform in July than in January. Between the northern tier of States (east of the Rocky Mountains), with mean temperatures of within a few degrees of 70°, and the southern tier and the Gulf States, with temperatures within a few degrees of 80°, the difference is so small that it attracts attention. On the other hand, the temperature differences between north and south in January are striking because they are so large. In July, the rate of change of temperature between New Orleans and Duluth is, in round numbers, only about 1° F. per latitude degree, while on the Atlantic coast, between Key West, Fla., and Eastport, Me., it is about 0.8°. So far as the mean temperatures alone are concerned, therefore, a long journey from south to north in search of decidedly cooler summers gives far less change than the corresponding trip from north to south in winter in search of much warmer and balmier climates. Other factors, however, serve to give the northern summer resorts their popularity. Among these are the frequent spells of cool weather; the advantages of cool fresh or salt water bathing; the lower temperatures, due to elevation, found in the mountains of New England and New York; and other conditions. The July isotherms show quite clearly the cooling effects of the Appalachian Highland in the warping of the lines and in the occurrence of temperatures averaging 5°, or even 10°, below those of the surrounding lowlands.

The tempering effects of even relatively moderate altitudes are shown in an interesting way by the course of some of the isotherms which are prominent features of the July map in the eastern United States. Take the case of the 70°-isotherm, for example. This line follows along the eastern base of the Rocky Mountain system from southern New Mexico northward to northeastern Wyoming, and then makes an abrupt turn eastward across the northern tier of States. Stations at no very great elevations in southern New Mexico are thus seen to have the same mean July temperatures as a long line of places reaching across northern South Dakota, central Minnesota, Wisconsin and Michigan, much of New York, and also southern New England. The situation is somewhat similar, but less marked, in the case of the 75°-isotherm. The tempering effects of the Great Lakes may be seen in the warping of the isotherms. Grand Haven, Mich., has mean temperatures 1° cooler than those of Milwaukee, Wis., in July and August, and 3°–4° cooler, between April and August, than those of a group of inland stations on the same latitude west of Lake Michigan.[13] Michigan stations on the immediate Lake shore are naturally also cooler than those situated somewhat inland, but this cooling influence on the mean monthly temperatures extends only to a distance of 20 or 25 miles inland, according to Henry.[14] Near the Atlantic coast the isotherms "double on themselves abruptly," as Blodget put it, indicating cooling "due either to the southward flowing cold surface currents or to the upwelling of cold water."[15] The northern coast of Maine has notably cool summers, cooler than those of the eastern coast of Asia in the same latitude.

Over the western Plateau province, the isothermal map is essentially a rough contour map. July mean temperatures below 55° are shown in certain portions of the Rocky Mountains in Montana, Wyoming, Colorado, Utah, and northern New Mexico; also on the Cascades of Washington and Oregon and the Sierra Nevada of California. Much of the Plateau province has from 65° to 75°. The highest monthly mean (over 90°) occurs over a restricted area of southwestern Arizona and southeastern California. This "heat island" is much smaller and less conspicuous than it appears on earlier charts, as, e. g., on the *Challenger* July (sea-level) isothermal chart, where the 90°-isotherm incloses a considerable part of the Southern Plateau region. The close crowding of the isotherms on the mountain and plateau slopes; the distinctly lower temperatures at the greater elevations, and the contrast between the excessively heated southern deserts and the much cooler, more elevated, stations not far away, are the most striking features in this western interior district. The effects of altitude are here so considerable that latitude and land and water controls are of relatively subordinate importance. Hence the popularity, at least in part, as summer vacation resorts, of the mountains of Colorado; of Yellowstone National Park, and of other parts of the Rocky Mountain district.

On the Pacific slope (Pacific province) there are three very striking features on the map. (1) The seaward isotherms closely parallel the coast line, giving, as Blodget remarked, "almost absolutely equal temperatures" along this coast.[16] One may travel from the Strait

[13] C. H. Eshleman, *loc. cit.*

[14] See also H. J. Cox and J. H. Armington, The Weather and Climate of Chicago. Large 8vo. Chicago, Ill., 1914, pp. 37–46, 142–145, on the influence of Lake Michigan on temperatures at Chicago.

[15] *Atlas of Meteorology*, p. 12.

[16] *loc. cit.*

of Juan de Fuca as far south as San Francisco without any change in the mean monthly temperature, and continue the trip to the southermost part of the coast without reaching a mean temperature as high as 70°. The temperature gradient along the entire length of the Pacific coast, from San Diego to the Strait of Juan de Fuca, is only 0.7° per latitude degree, i. e., one may travel north nearly 1,200 miles without changing the mean temperature more than about 12°, or 1° to 100 miles. (2) A second notable feature is the extraordinarily rapid temperature gradient between the immediate seacoast of southern California, with its cool summers resulting from the prevailing onshore winds, and the greatly heated interior desert of southeastern California. The west-east gradient from the coast to the southern portion of the San Joaquin Valley is also very rapid. This phenomenon "of the juxtaposition of Scottish and mid-African summer conditions" is almost, if not quite unique.[17] The superheating of these interior districts is due to their low latitude, abundant sunshine, dry air, and effective inclosure from the sea. (3) The third feature is the marked contrast between the higher temperatures of the interior valleys and the cooler mountain slopes. This is especially well seen in California, where the Sacramento-San Joaquin Valley stands out clearly by reason of its fairly uniform high temperatures. The increasing resort to the Sierra Nevada during the summer months finds a simple explanation in these conditions of temperature. This topographic control is naturally less marked farther north. The summers on the Pacific coast are as a whole several degrees cooler than those on the Atlantic.

Average winter and summer temperatures.—The average temperature of the three winter months is shown in chart 3, which summarizes, in a convenient form, the temperature conditions of this season. Owing to difficulties in reproduction, it is necessary, unfortunately, to omit the chart showing the average temperature of the three summer months. However, reference to chart 2 will reveal the essential characteristics of the summer season.

Mean annual ranges of temperature.—The seasonal contrasts in temperature are conveniently summarized by means of the so-called mean annual ranges, which shows the difference between the mean temperatures of the warmest and coldest months.[18]

Previous charts were based on sea-level, not on actual, temperatures. The new isothermal charts for January and July have now made it possible, by a comparison of the lines of actual temperatures for these two months, to study for the first time in great detail the ranges in all parts of the United States.

The greatest differences between the mean temperatures of January and of July are found over the northern interior region between the Rocky Mountains and the upper Lakes, viz, 55°–60°, and even slightly over 60° in some cases. From this center, the ranges decrease in all directions.

It is to be observed, however, that the continental characteristics of warm summers and cold winters prevail even to the extreme limits of the land area to the east. The absence of any effective mountain barrier to the west, somewhat inland from the coast, and the prevalence of offshore winds, explain this condition. Thus, ranges of 40°–50° are found even along the central and northern portions of the coast. The modifying effects of latitude and of the Gulf of Mexico are seen in the somewhat smaller ranges which prevail in the Gulf Province (25°–30°, or less). Most of the rest of the eastern province has 40°–50°. Over the southern Plains and much of the Plateau province the ranges run from slightly above to somewhat below 40°.

The annual migrations of the isotherms and of the temperature belts.—Too much emphasis upon the conditions in January and in July gives a misleading impression of the actual march of temperature through the year. It is important to have clearly in mind the fact of the continual advance or retreat of the isotherms, not only month by month, but week by week, and even day by day. The isothermal chart of any one month is merely a "snapshot" of conditions which are in a constant state of flux. It represents no rigid, fixed, permanent situation. It is, therefore, instructive to view the isothermal charts of the 12 months together. (Charts 1, 2, 4–13.)

January and July are the extreme types. They simply show the limits reached during the seasonal migration poleward and equatorward. Each of the other maps is almost as important, in that it marks another stage of advance or retreat. With the northward advance of the sun, the succeeding months of late winter, spring and early summer show the gradual rise in the temperatures everywhere, the changes being greatest over the northern and interior districts which have the greatest mean annual ranges. The seasonal northward advance of the isotherms is naturally most readily seen over the eastern United States, where the lines of equal temperature are well separated and follow more or less along the latitude circles. Even a cursory glance at the charts for January to June shows the northward movement of isotherms which are over the Gulf States in midwinter and travel northward so far that they leave the United States altogether, moving across the International Boundary into Canada. The gradual spreading apart of the eastern isotherms as the season advances is also very obvious. In January, 12 isotherms are shown between the northern Plains and the Gulf of Mexico. In July, when the continent is well and very uniformly warmed, there are only three. Over the Plateau districts, the general system of the isotherms remains more or less the same, month by month, but the lines are on the whole somewhat more crowded during the warmer months in certain areas, indicating greater differences of temperature between lowlands and uplands in summer than in winter in those localities. The seasonal increase in all the temperatures is readily seen if the figures on the chart are studied. On the immediate Pacific coast the parallelism of isotherms and coastline remains a constant feature on all the maps, and the seasonal changes in the actual temperatures are, as already pointed out, relatively slight.

During the cooling months (August–January) the isothermal system travels equatorward. Lines which in summer extended well north over the United States now travel so far south that they disappear from the map, e. g., the 70°- and the 75°- isotherms. In their place isotherms which in July were far north in the Arctic regions, or which did not even appear at sea level at all, gradually move equatorward and one after another appear on the charts. Over the western mountains and plateaus, and to a less marked degree over the eastern Appalachians, the advance of the colder season means the gradual descent down the slopes, to lower and lower levels, of isotherms which during the colder months were

[17] *Atlas of Meteorology*, p. 12.

[18] The standard chart of mean annual ranges for the world, based on the *Challenger* sea-level isotherms for January and July, is that of J. L. S. Connolly: A New Chart of Equal Annual Ranges of Temperature, *Amer. Met. Journ.*, vol. 10, 1893–94, pp. 505–506. This chart is reproduced in *Atlas of Meteorology*, pl. 2; text, p. 8; in W. M. Davis: Elementary Meteorology, fig. 18, and elsewhere. No more recent chart is available for the United States.

either far up on the upper slopes or even in the free air far above the tops of the highest mountains. Thus the sun is forever impelling advances and retreats, ascents and descents of all isotherms on all maps. There is no such thing as a fixed condition of temperature distribution. When this conception is thoroughly in mind, isothermal maps have a new meaning. They are no longer dead and rigid, but are full of movement, suggesting an infinite number of relations between the everchanging temperatures and all of human life and activity.

January and July have been referred to as everywhere the coldest and warmest months. This is true for the vast majority of stations, and in the long run. There are, however, a few stations exposed to marine influences on the Pacific coast, or on the Great Lakes, which have retarded maxima or minima. February may then become the coldest month or August the warmest. San Francisco is unique in having its warmest month September, and its October is actually warmer than its July and its August. This peculiar conditions results from the prevalence of strong onshore winds blowing through the Golden Gate in summer and induced by the excessive heating of the interior valley. The hotter the valley the more marked are these inflowing cool winds from the Pacific Ocean.

The advent of spring.—The so-called "advent of spring" may be said to occur when the physiological life of trees and plants awakens, after the quiescent stage of the colder months. The temperature of 42.8° F. (6° C.) being about that at which the life of the plant cells begins to stir, a chart showing the position of the isotherm of 43.8° (1° above 42.8°) at the beginning of February, March, April, and May may be taken as indicating the dates of the advent of spring in different sections of the country. Such a chart, proposed 30 years ago by Harrington, shows that spring really comes from the southward and westward, i. e., it advances northward and eastward.[19] The progress is not a steady one, but occurs as a series of advancing and retreating fluctuations, associated with the occurrence of warm and cold waves, "each advance of warmer weather penetrating a little farther into the cold interior and each successive chilling halting a little north of the southern limit of its predecessor, until finally * * * summer conditions are firmly established."[20] It has been pointed out by Henry that the statement concerning the advance of spring from south and west is really strictly applicable only to the northern portions of the Missouri, Mississippi, and Ohio Valleys.[21] On the Pacific coast plant activity, to a greater or less degree, continues through the colder months, and over the rough and broken topography of the Rocky Mountain and Plateau districts frequent local spring frosts, following warm days, interfere with the orderly advance of spring.

The temperature gradients and their economic significance.—With the warm Gulf of Mexico in the south, and cold continent to the north, the January isotherms over the eastern United States must necessarily be closely crowded, as already pointed out. The rapid January poleward temperature gradient on the Atlantic coast from southern Florida to northern Maine (about 2.5° per latitude degree), already referred to, remains essentially the same if Labrador be taken as the north end of the scale instead of Maine. Considering the distance, this is the steepest temperature gradient in the world. Where such rapid temperature gradients occur elsewhere, they are limited to much shorter distances, as, e. g., in the case of the opposite sides of mountain ranges. It is a noteworthy fact that in the United States there are no transverse mountains to help in the production of this remarkable contrast between north and south. Woeikof first called attention to the economic importance of this steep temperature gradient.[22] The products of tropical and of polar lands are here separated by less distance than is the case anywhere else in the world. At the same time, communication between these districts of sharply contrasted climates and types of vegetation is easy. Labrador is an Arctic land, where man's food must be sought chiefly in the ocean. Florida, on the other hand, is in many respects tropical. This idea has been somewhat expanded by Miss E. C. Semple.[23] "This approximation of contrasted climatic districts in North America was an immense force in stimulating the early economic development of the Thirteen Colonies, and in maturing them to the point of political autonomy. It gave New England commerce command of a near-by tropical trade in the West Indies, of subtropical products in the southern colonies in close proximity to all the contrasted products of a cold climate—dense forests for naval stores and lumber, and an inexhaustible supply of fish from polar currents, which met a strong demand in Europe and in the Antilles. The sudden southward drop of the 0° C. annual isothermal line toward the St. Lawrence and the Great Lakes brought the northwestern fur trade to the back gate of New York, where it opened on the Mohawk and upper Hudson, and brought prosperity to the young colony."

A steep poleward temperature gradient is a perfectly normal condition on the east coast of continents in middle latitudes, as a result of the prevailing winds and the system of ocean currents. Nevertheless it is significant that the January poleward gradient in eastern North America is nearly twice as great as that in eastern Asia (about 1.5°). The explanation was given by Woeikof. North America has a warm body of water—the Gulf of Mexico—on the south. There is also an increasing prevalence of warm (SW.) winds toward the southern portion of the Atlantic coast district, while cold northwesterly winds distinctly predominate in the north. In eastern Asia, on the other hand, cold offshore winds prevail as far south as the Tropic, and a cold land occupies the position of the Gulf of Mexico. North of latitude 50° N., the mean annual temperatures in eastern Asia and eastern North America are more or less alike. Farther south, eastern Asia becomes distinctly colder, especially in winter. As Hann put it, "comparing eastern Asia with eastern North America, the latter is not too cold in the north but too warm in the south. It is to this fact that the more rapid change of temperature with latitude in North America is due. The winters on the east coast of Asia are more severe than those on the American coast. Even the interior of America is much warmer than the east coast of Asia in corresponding latitudes."[24] A comparison between eastern North America and the west coasts of Europe and of northern Africa was apparently first clearly made by Humboldt, who pointed out that the mean annual temperatures found in the higher latitudes (55°–70° N.) on the European side of the Atlantic occur 10°–12° of latitude farther south in North America. In middle latitudes (about 45° N.), this difference decreases to about 4°–5° of latitude. At latitude 30° N. the difference between the two sides of the Atlantic disappears.

[19] M. W. Harrington: The Advent of Spring, *Harper's Mag.*, May, 1894, pp. 874-879.
[20] A. J. Henry: Climatology of the United States, p. 21.
[21] *Loc. cit.*
[22] A. Woeikof: Die Klimate der Erde, 1887, pp. 43-44.
[23] Ellen C. Semple: Influences of Geographical Environment, 1911, p. 618.
[24] J. Hann: Handbuch der Klimatologie, 3d ed., vol. 3, pp. 354-356.

The January poleward temperature gradient on the west coast of Europe is slightly less than 1° F. per latitude degree, as against more than 2.5° F. in eastern North America. The January gradient along the whole Pacific coast of North America as far as Sitka, Alaska, is essentially like that of Europe, and is thus only slightly over one-third of that along the whole Atlantic coast. The July gradients on the west coast of Europe (0.65°) and the east coast of Asia (1°) may be compared with those on the Atlantic coast of North America (about 1°) and the Pacific coast of North America (about 0.7°).

The occurrence of months and of seasons warmer or colder than normal.—It is a widespread popular belief that individual months, in different years, are often much warmer or colder than the normal for those months. The expression is a familiar one, "this February was the coldest I ever experienced," or "September was the hottest I remember." This belief is usually based, not on the fact that the mean temperature of the month in question may have been a degree or so higher or lower than the normal for that month, but rather on the values of the highest and lowest temperatures, and on the way in which these were distributed, i. e., on the "spells" of heat or cold, and on their severity. In fact, it frequently happens that people think that a month was colder than normal when its mean temperature was actually somewhat above the normal, and vice versa. In other words, the departure of the mean monthly temperature from the normal can not, in most cases, be estimated by the general impression of heat or cold which the month made.

It is a fact that the mean temperature of the same month in different years does depart a considerable amount, over much of the United States, from the general mean temperature of that month as derived from the whole series of observations. Almost any random publication which includes the monthly mean temperatures for a series of years, or which gives, for any single year, the departures of the mean monthly temperatures in that year from the normal, will furnish illustrations of this point. It is, for example, no uncommon thing in any individual year to have December or February colder than January, although in the run of the years January is the coldest month. When the average of the departures from this general mean are determined (regardless of whether they are + or −), the *mean departures of the monthly means* from their average values are obtained.[25] The calculation of such data is laborious, and has not been carried out to any considerable extent. The available results are, however, sufficient to warrant broad generalizations. Supan and Hann determined mean departures of the monthly means for certain parts of North America.[26] Henry has given the most recent tabulation, for a few stations only, from which it appears that the January departures are of the order of 6°–7° on the northern Plains. From this region of maximum average departures there is a decrease to the west, south, and east. The departures for January on the Pacific coast are of the order of 2° to about 2.5°; over the southern Plateau, the Southern Plains, and the Gulf States, about 3°; 3°–4° in the Lake region, New England, and the central tier of States east of the Rocky Mountains generally. In July, all these departures are reduced to one-half, or less than one-half.[27] The mean temperatures of winter months in the interior of North America are as a whole subject to greater fluctuations than is the case in northern Germany, and almost twice as great as those in England.

While such variations in the mean temperatures of the individual months in different years are significant, they are of slight physiological interest. (1) These differences come a year apart. (2) The monthly means, as has been stated above, are usually not values which can be determined by one's sensations. (3) Furthermore, within a year, many other fluctuations of temperature occur, much closer together and of much greater amount, which are directly observable and have many direct physiological and economic effects.

Extreme limits of the mean temperatures of individual months.—People are also naturally interested in knowing what mean temperature the coldest January, or the warmest February, etc., on record, actually had. When such data are available, a chart may be drawn showing just what difference there has been, within the period of record, between the mean temperatures of any given month. Such charts have been constructed by Henry, and published in 1906.[28] They show what is known as the absolute range of the monthly mean temperatures. Over a large portion of the central United States, including nearly all of the Missouri and the middle and upper Mississippi valleys, the mean monthly temperatures of January have differed by 25° and more. To illustrate, a station whose January mean temperature is 10° may have had one January with a mean of 25°, and one with a mean of 0° or even slightly below. Such departures, having occurred during a relatively short period of observation, are of course likely to occur again, and even to be exceeded. From the interior district of the largest ranges there is a decrease in all directions. Over the Atlantic and Gulf coasts the oscillation of the monthly means is roughly 15°–20°. On the Pacific coast and in the southwestern interior it is smaller (8°–16°). In July, the amount of such oscillations is about one-half of those of January. The California coast has essentially the same conditions in the two months.

In connection with this same subject, charts 14 and 15 are interesting. They show the lowest monthly mean temperatures recorded in January and in July during the period 1895–1914, as shown by the records of about 200 regular Weather Bureau stations. Chart 14 should be compared with chart 1, and chart 15 with chart 2. It will be observed that the *lowest* January mean temperatures have run about 5°–10° below the *average* mean temperatures, the departures being smallest on the Pacific coast and in Florida. In July, as is to be expected, the departures are smaller, being about 5°, or less.

Traditions regarding unusual seasons.—As far back as tradition and the non-instrumental record of white men in the United States extend, there are references to the occurrences of "unusually" severe or mild winters, and of "unusually" hot or cool summers. There were winters in northern sections when there was little ice; when flowers blossomed outdoors; when the ground was hardly frozen. There were also winters when the intense cold lasted almost without interruption; when snows were deep; when outdoor occupations and transportation were greatly interrupted. In the Records of the Roxbury (Mass.) Church, kept by Rev. John Eliot, the Apostle to the Indians, the winter of 1646–47 is described as having brought "no snow all winter long, nor sharp weather," so that it was possible to "go

[25] Also known as the variability of the monthly mean temperatures.

[26] J. Hann: Handbuch der Klimatologie, 3d ed., Vol. I, p. 26; Lehrbuch der Meteorologie, 3d ed., p. 110; A. Supan: Grundzüge der Physischen Erdkunde, 3d ed., 1903, pp. 101–102.

[27] A. J. Henry: The Climatology of the United States, *Bulletin Q*, U. S. Weather Bureau, pp. 31–32.

[28] Loc. cit., Charts XVII, XVIII.

preach to the Indians all this winter, praised be the Lord." Similarly, there are accounts of "unusually" hot, and of unusually cool summers. The summer of 1816 was a "record-breaking" one. Chauncey Jerome, who was then living in Bristol, Conn., wrote: "I well remember on the seventh of June, while on my way to work, about a mile from home, dressed throughout with thick woolen clothes and overcoat on, my hands got so cold that I was obliged to lay down my tools and put on a pair of mittens which I had in my pocket. It snowed about an hour that day." And again: "On the fourth of July I saw several men pitching quoits in the middle of the day with their overcoats on." [29]

Recent studies of exceptional seasons.—It is, however, only very recently that any detailed studies of the actual temperature conditions of such abnormal seasons have been made. To take a recent example, the winter of 1917–18 was remarkably cold, with heavy snowfalls, over an enormous area east of the Rocky Mountains. The autumn months were in many cases the coldest on record. December and January "defied the memories of the oldest inhabitants;" new minimum temperatures were registered far and wide. Heavy snows, with intense cold, brought serious economic and transportation disturbances over northeastern districts. Even in the South, truck gardens and fruit crops were seriously damaged. On January 12, 1918, a blizzard, with snow driven by a gale and at a temperature as low as —20°, resulted in an almost complete interruption of traffic during two days.[30]

The winter of 1920–21, on the other hand, was one of unusual and persistent mildness east of the Rocky Mountains. Kincer has given a graphic description of the "involuntary climatic travels" made by the inhabitants of different portions of the eastern United States. The high temperatures were the equivalent of travel over considerable distances to the south.[31] "The people in central North Dakota, climatically speaking, spent the winter near the South Dakota-Nebraska boundary line; those at Sioux City, Iowa, at Kansas City, Mo.; southern Indiana in northern Tennessee, and Washington, D. C., in southern Virginia." In 1919–20, a colder winter than usual, "Richmond (Va.) came north, climatically, to Washington to spend that winter, and went south to Raleigh, N. C.," in 1920–21.

It has not yet been possible to work out in detail the actual causes of these marked monthly and seasonal variations in temperature in different years. The explanation, in the United States as elsewhere, undoubtedly lies in the general distribution of pressure over the continents and oceans, i. e., in the development and location of the centers of action, and in the resulting effects upon the numbers, intensity, and paths of cyclones and anticyclones. It is as yet too early to say in just what ways the variations in the intensity of solar radiation may act to bring about these results.[32]

Do temperatures show any permanent change?—While monthly and seasonal mean temperatures are, as has been seen, subject to wide fluctuations, there is no unimpeachable evidence that any *permanent change* in temperature is taking place, or has taken place within historic times, in the United States. Periodicities, of varying lengths of years, have been suggested by numerous writers. The results differ widely. There is no general agreement except in the case of the Brückner 35-year period. The amount of temperature-difference, where such has been reported, is relatively very slight, and furnishes no basis, as yet, for making any reliable scientific long-range forecasts of general economic value. A discussion of these investigations can not be entered into here. The first thorough study of this subject was made by Schott, in his monumental analysis of the temperatures of the United States, in which he collected, reduced, and discussed all the older records.[33] Nothing was found which led to the view of any progressive change, although there was evidence of similar fluctuations of temperature over considerable areas, e. g., a period of about 22 years on the Atlantic coast and one of about 7 years in the interior. The long record of the opening and closing to navigation of the Hudson River at Albany, N. Y., indicates no progressive change in these dates.

Some 20 years ago, W. B. Stockman compiled temperature data for 10 stations, mostly east of the Mississippi River, covering 50 years.[34] The conclusion was that "the contention that the winters of recent years are less rigorous than those of former years, at least so far as temperature is concerned, is not well founded."

In a recent study of temperature variations in the United States, Henry has investigated the question to what extent periods of abnormally high and low temperatures synchronize, and also whether or not there is evidence of a periodicity in the occurrence and recurrence of these phenomena.[35] The data covered the period 1888–1919. It appears that in the United States the range in temperature from the year of highest temperature at sunspot minimum (1900) to the year of lowest temperature in a year of sunspot maximum (1917) amounts to 2.5° F. "The bulk of the evidence points to a period of between three and four years, or a third of the sunspot cycle, as being (the length of the period of oscillation) most commonly experienced."

In several cases a study of the records has shown that there is often, for a time, a certain sequence in the occurrence of especially cold, or warm, or rainy, or dry seasons. Facts of this sort have here and there been made use of in making very generalized long-range forecasts. Brooks has recently discussed the sequence of mild and severe winters in the northeastern United States.[36] An examination of the mean winter temperatures since 1812 shows apparently no other than a chance relationship four-fifths of the time. The other fifth includes two notable series of "alternating cold and warm winters, with almost identical preliminaries of a few moderately mild winters, an ordinary or moderately cold winter, and then a severe winter, which opens the alternating series —severe, warm, severe, warm, etc. The opening severe winters in these two series were those of 1872–73 and 1917–18. Thus we examine with interest the records of the winters of 1876–77, 1877–78 * * *, 1882–83, and

[29] History of Clock-Making. Numerous accounts of unusual seasons in New England will be found in Sidney Perley: Historic Storms of New England, Salem, Mass., 1891.

[30] An interesting account of this remarkable winter has been written by Dr. Charles F. Brooks: The Old-Fashioned Winter of 1917–18, *Geogr. Rev.*, vol. 5, 1918, pp. 405–414. See also P. C. Day: The Cold Winter of 1917–18, Mo. WEATHER. REV., vol. 46, 1918, pp. 570–580.

[31] Joseph B. Kincer: Our Involuntary Climatic Travels (with Special Reference to the Warm Winter of 1920-1921), Mo. WEATHER REV., 1921, 49; 18–20. Chart.

[32] See, in this connection, E. H. Bowie: Long Range Weather Forecasts, in *Weather Forecasting in the United States*, U. S. Weather Bureau, 8 vo., Washington, D. C., 1916, pp. 341–348; C. F. Brooks: World-Wide Changes of Temperature, *Geogr. Rev.*, vol. 2, 1916, pp. 249–255; W. J. Humphreys: Physics of the Air, 8 vo., Philadelphia, 1920, pp. 614–625; J. Hann: Lehrbuch der Meteorologie, 3d ed., 1915, pp. 637–644; E. A. Beals: Meteorological Centers of Action in the North Pacific Ocean (Abstract), Mo. WEATHER REV., 1921, 49; 330–331.

[33] Charles A. Schott: Tables, Distribution and Variations of the Atmospheric Temperature in the United States and some Adjacent Parts of America. *Smithson. Contr. to Knowl.*, XXI, 1876, pp. 302–320.

[34] Wm. B. Stockman; Invariability of our Winter Climate, Mo. WEATHER REV., 1904, 32; 224–226.

[35] Alfred J. Henry: Temperature Variations in the United States and Elsewhere, Mo. WEATHER REV., 1921, 49; 62–70.

[36] Charles F. Brooks: Sequence of Winters in the Northeastern United States, Mo. WEATHER REV., 1921, 49; 71–73.

wonder whether the winters of 1921–22, 1922–23 * * *, 1927–28, will alternate cold, warm, cold, etc., as those of 45 years ago did for such a long period * * *. Even if we can not say for winter after winter what the character is likely to be, we can say that immediately after a cold winter the chances are two to one or better in favor of a mild or warm one, and that a period of alternating cold and warm winters which is general over a large part of the eastern United States may continue for several winters, as cold, warm, cold, etc."

Temperature changes during 24-hour intervals.—There are two fundamental types of temperature changes during the conventional 24-hour time unit. One is the normal change, on fine days with marked solar control, from just before sunrise to shortly after noon—from a cool night to a warm afternoon. The other is the irregular change, not related to the time of day, due to winds, clouds, etc., and resulting from cyclonic or anticyclonic controls. There are, obviously, all varieties of combinations of these two types. The first, i. e., the so-called normal diurnal type, is chiefly characteristic of the semiarid western plateau district, where a prevailing small amount of cloud, dry air, and sparse vegetation favor strong sunshine by day and active radiation at night, but is also a common feature elsewhere, especially during the warmer months and in the Southern States. The second, i. e., the irregular cyclonic type, is mainly characteristic of northern and eastern sections. It is also relatively frequent during the colder months everywhere, being least marked on the southern Pacific coast and in the South and Southwest. This type is best developed when the cyclonic control is strongest, in winter, but occurs with reasonable frequency, although with greatly diminished intensity, in connection with the weaker cyclonic control of summer. Blodget first clearly emphasized the fact that the regular diurnal (i. e., solar) control is dominant in the West, while changes "of what may be called the greater nonperiodic sort" distinguish the East. "Extreme contrasts, diversities, and transitions belong here (in the interior) to *place* or *locality;* in the East to *time.*" This is a significant statement. It emphasizes the importance of the regularity of the solar control, and of the part played by the topography in the West. In the East, *per contra*, the time of the arrival and departure of cyclone or anticyclone is the deciding factor.

The common designation for the temperature differences which occur during a day is the diurnal range.[37] The greatest daily ranges of temperature, resulting from the normal warming by day and cooling by night, occur over the western plateau province and in summer. Here, in July (chart 17), practically the whole area has average daily ranges over 30°, and much of it has ranges of over 35°. Differences of 50° between early morning and noon are common. Individual cases of a rise from near the freezing point to 80° and even to 90° are on record. Over the eastern province the daily ranges are considerably less. They decrease from about 30° over the Plains (July) to less than 20° over the Great Lakes, along the Atlantic and Pacific coasts, and over the Gulf province. On much of the immediate Atlantic, Gulf, and Pacific seacoast the ranges are under 15°. The daily temperature ranges of summer over the eastern interior are relatively small, considering the continental climate and the high temperatures. Hann has attributed this fact to the high humidity of summer, which gives an almost tropical character to the climate at that season—a climate marked by relatively small daily ranges of temperature.[38]

The average daily temperature ranges for January are shown in chart 16. On the whole, these ranges are smaller than in July, especially over the western Plateau province, where the diurnal control is least marked in midwinter.

The sudden, irregular temperature changes which occur under cyclonic and anticyclonic control, and are chiefly characteristic of the East, may be as great as those which are due to normal diurnal control in the West. Thus, a winter warm spell with southerly winds and a temperature in the neighborhood of 50° may be followed within 24 hours by a cold wave with zero temperatures over the northern tier of States. Remarkably sudden temperature changes also occur in connection with chinook winds along the eastern base of the Rocky Mountains. Or, in summer, during a hot wave, the advance of a cyclonic cloud sheet and the setting in of cool easterly winds on the Atlantic coast "breaks" the heat within a few hours, bringing welcome relief. Several different types of weather bring these "paroxysms of change" (Blodget).

Highest and lowest "record" temperatures.[39]—Great popular interest always attaches to the "record" highest and lowest temperatures. Obviously, the longer the period of observation, the higher and lower these absolute maxima and minima will be. Chart 18, which supersedes all the older charts of absolute minima, shows the lowest temperatures ever observed in the United States, and is based on the records of about 600 stations. The lowest readings of standard thermometers, under proper conditions of exposure (−60° and a few degrees below) have occurred over the northern Plains, the gateway through which cold waves from western Canada enter the United States. Temperatures low enough to freeze mercury (−40°) have been recorded as far south as western central Colorado, northeastern Nebraska, and central Minnesota and Wisconsin.

Minima below zero have been observed over a large part of the United States. Starting from the Atlantic coast at the latitude of southern Virginia, the line along which zero temperatures have been recorded runs southwest, at some distance inland from the ocean, to northwestern Florida; then roughly parallels the Gulf coast, crosses Texas north of latitude 30° N. then turns northwest across southwestern New Mexico and central Arizona, keeping at first east of, then along and finally crossing to the west of, the Sierra Nevada-Cascade Mountains. It ends in western Washington, but does not touch the actual Pacific coast. Zero has not been recorded on the Atlantic coast south of Chesapeake Bay, on the immediate Gulf coast, or in the valley of California. It is a striking fact that the absolute minima over the northern Plateau west of the Rocky Mountain barrier, and also those along the eastern base of this barrier, are distinctly higher than those over the northern

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37 When the difference between the mean temperatures of the warmest and coldest hours of the day is given it is known as the *periodic diurnal range.* When the difference between the mean daily maxima and the mean daily minima (determined from readings of the maximum and the minimum thermometers on individual days) is given, it is known as the *nonperiodic diurnal range.* The latter is the one usually given in climatic tables and discussions. It is determined much more easily, and for all practical purposes may be used instead of the periodic range. When hourly temperature data are available, the periodic range is easily worked out. (In connection with this, see Alexander McAdie: "Mean Temperatures and Their Corrections in the United States," 1891; tables of mean hourly temperatures for regular Weather Bureau stations for the five years 1891–95, in *Ann. Rept. Chief of Weather Bureau* for 1896–97, pp. 94–107; also short table of mean diurnal periodic ranges, based on McAdie's report, given by Hann in his Handbuch der Klimatologie, Vol. III, 3d ed., 1911, p. 363.

38 J. Hann: Handbuch der Klimatologie, vol. 1, 3d ed., p. 362.

39 Henry has given (*Bulletin Q*, Table II, pp. 88–92) the absolute maximum and minimum temperatures for selected stations, with year of occurrence, for the period 1871–1903. More recent and fuller data will be found in the regular monthly and annual summaries published by the Weather Bureau. For information about the available charts, reference may be made to R. DeC. Ward: Bibliographic Notes on the Temperature Charts of the United States. MO. WEATHER REV., 1921, 49; 277–280.

Plains, in spite of lower elevations in the latter district. The effect of the barrier is here clearly seen. During inversions of temperature, which characteristically accompany the occurrence of the lowest minima, elevated stations are often considerably warmer than those near by, on lowlands or in valleys.

Similarly, the advance of cold from the northern Plateau districts to the Pacific coast is prevented by the barrier of the Sierra Nevada-Cascades. Key West, Fla., is now the only regular Weather Bureau station at which no minimum temperature below freezing has been recorded. The north is not, however, under all conditions, colder than the south. There are cases, not by any means extremely rare, when the southern tier of States is temporarily having colder weather than those to the north.

There is a considerable tempering of the extreme cold to leeward of the Great Lakes, as is shown by the warping of the lines of equal absolute minima, as, e. g., along the southern shores of Lakes Erie and Ontario and along the eastern shore of Lake Michigan. During severe winter cold waves the lee shores of these Lakes may have temperatures 10°–20° or so higher than those observed at the same time on the opposite (windward) shores.[40] Alexander Winchell, by means of his lines of equal absolute minima, first showed in a striking way the moderating influence of the Great Lakes, especially of Lake Michigan, upon the winter temperatures in their vicinity.[41] As shown by Eshleman in a much later study, the absolute minimum temperatures at Grand Haven in winter (Nov.–Jan.) run higher by about 10° than those at Milwaukee, and by about 12°–16° (Oct.–Jan.) higher than those of a group of western inland stations on the same latitude.[42] "Whole weeks of zero weather occur in Wisconsin and Minnesota when the temperature at Grand Haven will not go below 15° or 20°." The Lake influence is clearly seen in the occurrence of an extended and important fruit belt, which reaches from the southwestern corner of the State along the eastern shore of Lake Michigan as far as Grand Traverse Bay.[43] The famous peach region of Michigan forms part of this same belt. The absolute maxima, as shown on the new chart (chart 19), are surprisingly uniform over the United States as a whole. The differences are slight, and the lines of equal absolute maxima show no such well-defined system as is the case with the minima. For purposes of broad generalization, and of easy memorizing, it is perhaps enough to say that extreme temperatures of over 100° have been observed over most of the United States. The exceptions are the immediate northern coasts of Atlantic and Pacific Oceans; portions of the Lake region; central and southern Florida, the Texas coast, northern New England, and the higher parts of the mountain areas. Over all these last-named districts, the readings are from somewhat under 95° to a little under 100°. The tempering influences of the Great Lakes are again seen in the deflection of the lines of equal absolute maxima. The values are roughly 10° less on the eastern than on the western shore of Lake Michigan. Grand Haven has summer maxima lower by 6°–7° than those of Milwaukee and by 10°–15° lower than those of the group of western continental stations.[44] "A difference of 10° to 20° in the maximum temperatures (at Grand Haven) compared with inland stations on warm days is a common occurrence." The highest readings for the country as a whole exceed 120° in southwestern Arizona; maxima over 115° occur over a larger district of northeastern California, southeastern Arizona, as well as in the valley of California. The "record maximum" is 134°, recorded at Greenland Ranch, on the edge of Death Valley (July 10, 1913.[45]) Owing to the small scale of the map, the high temperatures in Death Valley are not indicated. It should be added, however, that the excessively high maxima of the far Southwest are associated with relatively dry air, and are far less oppressive, and less physiologically dangerous, than the lower maxima in the moister air of the east.

The average lowest temperature of the year.—The average lowest temperature reading of the year (mean annual minimum) not only has a general popular interest, but is also important because of certain of its economic relations. The new chart of average annual minimum temperatures (chart 20) replaces a far less complete one published by van Bebber in 1893.[46] A thermometer reading below —30° is a normal winter occurrence over the northern Plains and northern Minnesota. Northern New York and northern New England have —25°. Temperatures below zero are to be expected on the coast as far south as southern New England, southern New York, and northern New Jersey. From this section the line of mean annual minimum of zero runs in a general southwesterly direction across Maryland, Kentucky, northern Tennessee, southern Illinois and Missouri, northern Arkansas, Oklahoma, and northern Texas into eastern New Mexico. Thence it turns west and northwest, following along the eastern slopes of the Pacific coast ranges, and ending in eastern Washington. The Gulf States have minima mostly between 10° and 20°, with over 20° over all of Florida and along the Texas coast. The tempering of the cold by latitude is thus clearly indicated. Topographic controls are seen in the positions of the lines over the western plateau and mountain districts, e. g., in Colorado, New Mexico and Arizona. The Rocky Mountains obviously act as an effective barrier against the penetration of extreme cold from the northern Plains into the Plateau districts. No cold of eastern intensity is indicated in any portion of the great district to the west of the Rocky Mountains. The Pacific coast is further protected by the Sierra Nevada-Cascade barrier against the invasion of low temperatures from the east. On the immediate Pacific coast, the mean annual minima are 20° in the north and 30° in the south.

The irregularities of the lines in the Lake region, especially in the case of Lake Michigan and of the lower peninsula of Michigan, and of the lee shores of Lakes Erie and Ontario, show a very obvious tempering effect of the Lake waters.[47] The mean monthly minima at Grand Haven, Mich., run about 4°–6° higher than those at Milwaukee Wis., during the winter, and 10° ± higher than those of a group of inland stations somewhat farther west.[48]

One of the striking, and one of the serious, climatic characteristics of the eastern United States, is the temporary and sudden penetration of very low minima far to the south, into latitudes where the winters are distinctly mild. This condition occurs in connection with

[40] See, e. g., E. T. Turner: The Climate of the State of New York. *Fifth Ann. Report Met. Bur. and Weather Service of the State of New York.* 8vo. Albany, 1894, p. 370.

[41] Alexander Winchell: The Isothermals of the Lake Region. *Proc. Amer. Assoc. Adv. Sci.*, vol. 19, 1870, pp. 106-117.

[42] Loc. cit.

[43] A. J. Henry, loc. cit., p. 556.

[44] C. H. Eshleman, loc. cit.

[45] G. H. Willson: The Hottest Region in the United States, MO. WEATHER REV., 1915 43; 278-280.

[46] Reproduced in *Atlas of Meteorology*, 1889, pl. 2.

[47] See, e. g., J. Hann: Atlas der Meteorologie, 1887, text, p. 5.

[48] C. H. Eshleman, loc. cit.

the advance of a cold wave from north and west. A general knowledge of the mean annual minimum temperatures is here essential to a full appreciation of the climatology of this area. Hann pointed out that the temperature at New Orleans falls each winter on the average nearly to 20°, while at Cairo in the same latitude, it reaches only a degree or so less than 40°. Yet both mean annual and mean January temperatures at these two cities are essentially the same.[49] And over half a century ago, Russell noted the fact that Savannah, Ga., has a mean winter temperature similar to that of May in London and of winter in Cadiz, which is 4½° of latitude farther north.[50] Yet the vegetation of southern Spain is quite different from that in North America because of the higher winter minima in the former country. In a case like this, vegetation becomes a better index than is the mean temperature. Oranges are liable to serious damage by frost over nearly all of the southern United States; not so in southern Spain. Cotton is replanted annually in the United States; not so in Spain. It is true that spells of considerable cold also invade low latitudes in eastern Asia, but there the mean winter temperatures are lower than in the eastern United States.

The mean annual maxima have much less human and economic significance than the mean annual minima.[51]

Other facts concerning annual and monthly maxima and minima.[52]—The differences which have been recorded between the highest and the lowest temperatures ever observed are worthy of note. These differences are of the order of 150° in the north-central districts of the interior; 125° in northern New England and the lower Lake region; less than 100° along the Gulf coast; about 50° at Key West; 120° in the Rocky Mountain and Plateau region generally; in the southwestern interior, 110°; less than 100° on the Pacific coast, with the exception of the Columbia River valley and the mountains.[53] During a single month, differences of the order of 100° may occur over the northern interior in winter, between the extreme cold of a cold wave and the high temperatures of a warm spell. Although these monthly ranges decrease rapidly to the south, they are greater than those of central Europe at least as far as latitude 40° N. (Hann.)

The differences in temperature from day to day.—There are two fundamental controls determining the differences in temperature from one day to the next. One is regular; the other, irregular. The first is the sun. Under the sun's control alone, each day should normally be a little warmer than the preceding during the warming half of the year, and a little cooler during the cooling half. The second is the cyclonic and anticyclonic control. This is irregular, varying with the temporary conditions of pressure distribution and the accompanying temperature, winds, clouds, and rain. The second of the two controls is by far the most important over most of the United States and most of the time, especially during the colder season. It brings marked and sudden temperature changes from day to day, completely upsetting the orderly seasonal advance and retreat. These day-to-day changes in temperature are of great importance in relation to human comfort and health. They markedly affect a wide range of man's activities. The conventional method of expressing such changes is to give, for each month, the average difference between the mean temperatures of successive days.[54] In a table compiled by Supan some years ago it appears that the interior of North America, including the northernmost parts of the United States, is one of the two centers of maximum diurnal variability in the Northern Hemisphere.[55]

Generalizing broadly, it may be stated that the mean diurnal variability in winter is of the order of about 10° in the northern central interior, and decreases from there in all directions, to about 2.5° on the north and 2° on the south Pacific coast; a little over 5° on the Gulf Coast, and about 3° in southern Florida.[56] The decrease from the interior to the Atlantic coast is relatively slight, because this leeward coast shares so largely in the continental conditions of the interior. The lines of equal variability follow the lines of absolute minimum temperatures reasonably closely, indicating a dependence of the large diurnal variability of winter upon the occurrence of cold waves. The mean diurnal variability in summer is usually about one-half of that in winter. It should be observed that the foregoing data refer to differences between the daily *mean* temperatures, and not to the total amount of rise or fall of temperature from day to day. Such irregular changes are of striking frequency and of large values, especially in the northern United States east of the Rocky Mountains in winter, reaching 50° or even more within 24 hours.

Several factors combine to bring about these rather remarkable irregular temperature changes in the eastern United States, viz, the rapid winter poleward temperature gradient; the presence of the warm Gulf of Mexico in the south, the Gulf Stream off the east coast, and the cold continent to the north; and the frequency, intensity, and rapid progression of cyclones and anticyclones. Under the control of the rapidly changing pressure gradients as HIGHS and LOWS pass by, the winds are constantly changing their direction. Thus, large masses of air, often moving at high velocities, are imported from districts of widely varying temperatures, now from the warm Gulf of Mexico; now from the cold plains of western Canada; now from the Atlantic Ocean on the east. Marked and sudden changes in temperature and in general weather conditions are therefore inevitable. Furthermore, winds not only control temperatures directly, by the actual importation of warm or of cold air, but also indirectly, by bringing clear skies and thus increasing the local production of cold by nocturnal radiation on quiet nights and the warming under sunshine by day, or by bringing clouds and rain and thus cutting off sunshine by day and checking terrestrial radiation by night.

Does the annual march of temperature show persistent irregularities?—There is a widespread popular belief in the recurrence, at about the same time every year, of longer or shorter periods of unseasonable cold or heat. Among these "spells" of weather the ones most commonly referred to in the United States are the "January thaw," a cold period about the middle of May, and the

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[49] J. Hann: Atlas der Meteorologie, 1887, text, p. 5.

[50] Russell: North America, its Agriculture and Climate, Edinburgh, 1857. Quoted by J. Hann: Handbuch der Klimatologie, 3d ed., vol. 3, 1911, p. 364.

[51] No chart of mean annual maxima has been prepared since that of van Bebber, 1893.

[52] The complete numerical presentation of highest and lowest temperatures requires several columns in a standard climatic table (see, e. g., J. Hann: Handbook of Climatology, 2d ed., vol. 1, English translation by R. DeC. Ward, table on p. 33.)

[53] A. J. Henry, loc. cit, pp. 29–30. No map of the *mean annual extreme range* has been constructed since that of van Bebber, for the world (*Atlas of Meteorology*, Pl. 2). These ranges, also known as the *mean annual non-periodic ranges*, average about twice as large as the *mean annual periodic ranges* previously referred to, which are based on the differences between the mean temperatures of January and of July.

[54] *Mean diurnal variability of temperature*, i. e., the mean of the differences between successive daily means. Data regarding this factor have been worked out for comparatively few stations in the United States. See tables of "Average Daily Variability of Temperature" (for 18 selected stations), and of "Average Daily Variability of Temperature in Percentages, Washington, D. C., 1883–1903," in *Bulletin Q*, p. 33. Also *Ann. Rept. Chief of Weather Bureau for 1896–97*, p. 284.

[55] A. Supan: Grundzüge der Physischen Erdkunde, 3d ed. 1903, p. 99.

[56] See chart prepared by Gen. A. W. Greely, "Variability of average daily temperature in January," reproduced in F. Waldo's Elementary Meteorology, 1896. Fig. 101, pp. 330–332.

"Indian summer." Prof. Charles F. Marvin, Chief of the Weather Bureau, has recently investigated this question by making a study of the temperature records for several long-period stations in the northeastern United States, supplemented by 45-year records from Weather Bureau stations scattered over the country.[57] The conclusion reached is that the annual record of daily mean temperatures is a smooth curve, without secondary maxima or minima, or of perceptible points of inflection. Such marked irregularities as are described by the terms "January thaw" or "May freeze," neither persist, nor do they have a real existence. In cases where these or similar irregularities appear in the means, they are the effect of a single occurrence, or of a few accidentally recurrent unusual or extreme events, near or at the time in question. A study of the long-period temperature record s keptat New Bedford, Mass., between 1813 and 1905, was made by the late Waldo E. Forbes.[58] The object of this investigation was to discover evidence for or against the occurrence of a cold spell in New England about May 10 ("Ice Saints"). It appears that cold weather as well as hot may be expected on May 10, and hot weather as well as cold on May 7 or May 13. "It is nevertheless possible that when the pulsations of the weather are better understood, May 10 may prove to be a sort of node and may serve as a point of departure for the study of weather waves."[59]

ON THE DEPRESSIONS OBSERVED IN THE VALUES OF SOLAR RADIATION INTENSITY.

By LADISLAS GORCZYŃSKI.

[Translated by W. W. Reed, from *Bolletino Bimensuale, Soc. Met'l. Ital.*, Apr.-June, 1921, pp. 25-28.]

While very warm or rainy summers and very mild or cold winters come directly to general notice, depressions, and in general all the abnormal variations in the values of the intensity of solar radiation measured at the surface of the earth, do not manifest themselves immediately to the eyes of observers and require a scientific demonstration by special instruments known as pyrheliometers and actinometers.

Yet the study of these depressions, or rather of all the variations that appear in the values of solar radiation observed at the surface of the earth, has an importance all the greater since it is indeed the solar energy that is, in the last analysis, the *spiritus movens* in all the atmospheric movements observed on the earth. In order to find an explanation of the very complicated variations of temperature of the air and of precipitation it is necessary to begin with the study of solar radiation.

For this reason, we believe it useful to discuss briefly the two great depressions in solar radiation that have occurred since the beginning of the twentieth century; these are the depressions of 1902 and 1913, which we have demonstrated from pyrheliometric and actinometric measurements made at Warsaw without interruption since the close of 1900.

It is important to add that these depressions observed at Warsaw have been discovered in the series of measurements made at other observatories in Europe and in America;[1] these depressions have consequently a world-wide character.

To establish the existence of these depressions in the values of solar radiation observed at Warsaw let us take the monthly maxima (Max. Q) of the intensity of solar radiation. Granted that radiation is subjected in the earth's atmosphere to influences that always tend to diminish it, the conclusion is easily reached that it is especially the maximum values in the diurnal and annual periods that are the most characteristic. Besides the conclusions reached by examination of the monthly maximum values of radiation are confirmed by the consideration of the monthly mean values and also by the observation of the duration of insolation (in hours) and by the calculation of the totals of insolation (in kg. cal.) to one sq. cm. of the normal horizontal surface.

Being unable, in the present paper, to enter into the details of the matter, let us note that the results of the observations and calculations are found in the following publications by the author:

1. Valeurs pyrhéliométriques et les sommes d'insolation à Varsovie pendant la période 1901-1913. Warsaw, 1914. (*Publications de la Société des Sciences de Varsovie.*)
2. Sur les dépressions en 1912 et 1903 dans les valeurs de l'intensité du rayonnement solaire. Warsaw, 1914. (*Comptes Rendus de la Société des Sciences de Varsovie.*)

In Table 1 are presented the departures of the monthly maximum values of solar radiation at Warsaw during the period from 1901 to 1918. The departures (relative to the means for 1901-1913 and 1914-1918) are calculated in gr. cal. per sq. cm. per minute. The departures for the five years, 1914-1918, are given separately because of change in the place of observation in the first half of 1914, when the apparatus (Michelson actinometer and Ångström pyrheliometer) were transferred from the building of the Musée d'Industrie et d'Agriculture, situated more in the center of the city, to the building of the Société des Sciences of Warsaw, about 2 km. distant from the former.

Although, especially on account of the smoke of the city, both points of observation are far from favorable for measurements of solar radiation, it is of consequence to note that the latter place seems to be the better and gives higher values.

NOTE.—The values for 1901-1913 were calculated and published by the author (loc. cit.); the values for 1914-1918 were calculated by the observer, E. Stenz, but have not been published.

In the months for which departures are not given, actinometric measurements could not be effected.

Table 1 shows immediately that certain periods present depressions. In calculating the values of max. Q (for m, 1.5 atm. and f, 7 mm.) there is obtained the following

[57] Charles F. Marvin: Are there Persistent Irregularities in the Annual March of Temperature? MO. WEATHER REV., 1919, 47: 544-555. The same number of the REVIEW also contains a useful *annotated bibliography of this subject* (pp. 555-565), by C. F. Talman.

[1] See Kimball, Herbert H.: Volcanic eruptions and solar radiation intensities. MO. WEATHER REV., Aug. 1918: 46:355-356.

[58] Waldo E. Forbes: Ice Saints, *Am. Astron. Observatory Harv. Coll.*, vol. 83, pt. 1 1917, pp. 53-59.

[59] An early discussion of this subject may be found in C. A. Schott: Tables, Distribution and Variations of the Atmospheric Temperature in the United States and some, Adjacent Parts of South America. *Smithson. Contr. to Knowl.* 277. Washington, D. C. 1876. pp. 192-194.

TABLE 1.—*Departures (relative to means) of the monthly maximum values of the intensity (Q) of solar radiation at Warsaw.*

Month	January.	February.	March.	April.	May	June.	July.	August.	September.	October.	November.	December.
m (atm.)	3.5	2.5	2.0	1.5	1.5	1.5	1.5	1.5	1.5	2.0	3.0	4.0
f. (mm.)	3	3	4	5	6	8	9	8	7	6	4	3
Means *Q* (01-13)	0.87	1.03	1.11	1.21	1.19	1.19	1.19	1.16	1.22	1.13	0.95	0.80
Departures in hundredths of *Q*.												
1901	−1	13	−4	7	6	4	3	10	3	5	5	12
1902	0	8	7	2	−11	−6	8	6	10	−2	−12	−13
1903	−20	−20	−17	−21	−25	−3	−8	−16	−14	−8	....	....
1904	−18	−13	3	−3	7	−9	5	1	0	1	−5	−7
1905	1	3	−1	2	9	6	6	4	8	2	−6	1
1906	7	−6	3	5	5	5	2	−3	−1	10	22	13
1907	−1	4	0	1	1	−3	−2	5	1	9	12	−2
1908	8	−15	−8	−5	4	2	3	6	9	2	2	−3
1909	0	−1	2	−4	6	1	....	3	0	−4	....	12
1910	4	2	5	−1	1	0		−2	1	2		−1
1911	....	6	14	6	9	8	11	6	9	12	12	....
1912	32	17	−1	12	−5	3	−19	−16	−33	−30	−23	−13
1913	−12	−1	−5	−2	−1	−3	−3	−1	5	1	−11	−3
Means (1914-1918)	0.91	1.09	1.21	1.31	1.30	1.24	1.25	1.29	1.34	1.18	1.06	0.87
1914	−20	−4	−9	−1	−3	5	3	3	−6	−2	1	−3
1915	−15	−6	4	4	1	2	−6	3	1	8	−6	−1
1916	7	1	0	1	−1	−3	−6	−13	2	−6	−6	−2
1917	13	5	−4	4	6	−5	5	5	1	−1	0	1
1918	13	5	7	−6	−5	3	4	3	2	1	12	4

march of annual departure in percentage of the respective means.

1901	4	1910	1
1902	−1	1911	7
1903	−13	1912	−6
1904	−3	1913	−3
1905	3	1914	−2
1906	4	1915	−1
1907	2	1916	−2
1908	0	1917	1
1909	2	1918	2

We are at once impressed by the very large negative departures in 1903 and 1912 On further examination of Table 1 it is seen that the months with particularly lowered intensity are grouped in a very strikingly consecutive manner; they continue from November, 1902 to February, 1904 (with a slight relative increase in June, 1903), and from July, 1912, to January, 1913.

During these two periods the monthly maxima of intensity (*Q*) of the solar radiation at Warsaw were diminished without interruption (relative to the means for 1901-1913), and this diminution generally exceeded 10 per cent.

Let it be noted that the maximum values of intensity (*Q*) of solar radiation have been reduced uniformly to the atmospheric thickness (*m*) and the vapor tension (*f*) indicated in the headings for the different months. In addition all the values of table 1 have been reduced to the earth's mean distance.

The depression of 1903 continued approximately 16 months (November, 1902–February, 1904); here are the departures.

November, 1902	−12	July, 1903	−8
December, 1902	−13	August, 1903	−16
January, 1903	−20	September, 1903	−14
February, 1903	−20	October, 1903	−8
March, 1903	−17	November, 1903	...
April, 1903	−21	December, 1903	...
May, 1903	−25	January, 1904	−18
June, 1903	−3	February, 1904	−13

In November and December, 1903, measurements of radiation could not be made on account of too unfavorable condition of the sky.

This depression was observed not only in Poland, but at Lausanne (Switzerland) and at Pavlovsk (Russia); it was due to the eruption of Mount Pelée on Martinique.

The depression of 1912 was no less marked than the preceding one, but it continued only 7 months—from July, 1912, to January, 1913. Here are the departures in hundredths of a gr. cal. cm² relative to the means for 1901-1913.

July, 1912	19	November, 1912	23
August, 1912	16	December, 1912	13
September, 1912	33	January, 1913	12
October, 1912	30		

This depression was observed at several places in Europe and also in North America: it appeared simultaneously and suddenly in July, 1912, as is seen from the following table in which are grouped the monthly maxima (not reduced) of intensity of solar radiation for two consecutive months in 1911 and 1912.

	July.			August.		
	1911 (gr. cal.).	1912 (gr. cal.).	Diff. (per cent).	1911 (gr. cal.).	1912 (gr. cal.).	Diff. (per cent).
Warsaw (Poland)	1.33	1.03	23	1.22	0.99	20
Olczedajow (Podalia)	1.33	1.01	24	1.28	1.007	17
Pavlovsk (Russia)	1.34	1.02	24	1.30	1.00	23
Potsdam (Germany)	1.37	1.13	18	1.33	0.97	27
Paris (France)	1.25	0.96	23	1.22	0.95	22
Washington (United States)	1.37	1.05	23	1.33	1.02	23

This large depression was due to the eruption of the volcano Katmai (Alaska) observed on June 6-8, 1912, as has been noted by Mr. H. H. Kimball in America.

Let it be noted that the famous eruption of the volcano Krakatoa gave rise to a depression in intensity of solar radiation as appears from the series of measurements made at Montpellier (France) during the period 1883-1900. The curve at Montpellier shows a very deep depression (−12 per cent) in 1885, although the depression includes four years, 1883-1886.

Another depression was observed at Montpellier in 1891; we are ignorant of its cause.

The period 1893-1902 seems to be free of depressions, as appears from an examination of actinometric measurements at Montpellier (until 1901) and at Pavlovsk (with uninterrupted series since 1893).

With reference to Table 1, it is important to note that if for some other months of the period 1901-1918 there

are found at Warsaw occasional monthly maxima that are diminished relative to the means these months are rather scattered. This character is frequent during the winter months when clear days are rare at Warsaw and changes in max. Q (large departures negative or positive) become very considerable, but they are of local character.

But if it is necessary to be extremely careful relative to lowered values in winter we can not pass without examination of depressions of even short duration observed in summer when, in general, the number of clear days is large enough and the conditions are favorable enough for actinometric measurements. After the last marked depression of 1912 the years following have been rather normal relative to annual means, as appears from an examination of Table 1.

However, there is noted the depression in the summer of 1916 with the following departures (in hundredths of a gr. cal., calculated at the Central Meteorological Institute of Poland by E. Stenz):

June	−3	September	2
July	−6	October	−6
August	−13	November	−6

At first we were disposed to believe that here there was a matter of a rather local depression observed at Warsaw, although the days with sun not veiled were numerous enough and the sky appeared sufficiently pure. But the fact that the same depression was observed simultaneously at Florence and at Izana (Canary Islands) leads to the conclusion that here there is a matter of a phenomenon of more general character.

Let us note that the measurements at Florence are made with the Ångström pyrheliometer; the measurements at Izana (lat. 28° 15′ N., long. 16° 57′ W., elevation 2,100 meters) made with the Abbot actinometer (silver disk N. 25) have been published under the direction of the Central Meteorological Institute at Madrid.

The depression of the summer of 1916 was followed by atmospheric disturbances relative to optics and polarimetry, as has been demonstrated especially by Dorno at Davos (Switzerland). The cause of this depression has not been discovered; it is only admitted that it was not of volcanic origin. Let us add that this coincidence of depressions in the values of solar radiation and in the values of polarization does not always manifest itself; it occasionally happens that the diminution in the polarization of the sky is observed, although the values of intensity of solar radiation do not show parallel changes.

In closing this paper, let the attention of observers be called to the theoretical and practical interest of continuous measurements of the intensity of solar radiation made with tested apparatus.

PROLONGED PLANT ACTIVITY AT GRAND HAVEN, MICH., IN AUTUMN OF 1920.

By H. TULLSON, Meteorologist.

[Weather Bureau, Grand Haven, Mich., Dec. 20, 1920.]

Early in November of 1920 it was observed by many persons and commented upon in the newspapers that various wild plants were blooming later than usual in this vicinity. Up to November 10 no severe frosts had occurred, and there had been but three days with mean temperature below that generally necessary for plant growth, two of these having occurred late in October and one in November. As a consequence, the foliage of practically all the herbs, shrubs, and trees was still green. Though in previous years no systematic record with which to make comparisons had been kept, it was decided, early in November, to make notes during the rest of the season on the late blooming of wild plants [1] and the persistence of verdure. Accordingly, a suitable area was selected, and the vegetation thereon noted at intervals as long as growth continued. This tract is owned by Dr. Edward Hofma and embraces about 8 acres of lowland flats inclosed together with some marsh land by Grand River and one of its "ox bows." The ground selected is composed of quite firm soil, upon which flourish not only herbs but shrubs and small trees also. The characteristic vegetation of the adjacent marsh is cat-tail, reed, and wild rice.

A cold spell, with mean temperature somewhat below freezing, extended from November 11 to November 16, inclusive; but during this time a blanket of snow covered the ground, affording protection for the abundant herbage. The snow came in advance of the coldest weather; otherwise it is clear that the activity of practically all the vegetation would have been brought to a close in the second week of November. As it was, the leaves of the trees and shrubs—chokecherry, white dogwood, poplar, willow, etc.—were frozen at this time.

Beginning November 17 there was a period of warmer weather and the snow disappeared rapidly, while growing temperatures prevailed from the 18th to the 21st. On Thanksgiving Day, November 25, 20 species of wild plants were observed in bloom, which may safely be called an unusual number despite the fact that no previous records for comparison exist. These plants were the following: Dandelion, mallow, yarrow, white sweet clover, silvery cinquefoil (on adjacent uplands), common chickweed, peppergrass, blind gentian, common evening primrose, red clover, bouncing Bet, goldenrod (*Solidago altissima*), wild strawberry, white campion, beggar ticks (Bidens sp.), daisy fleabane (*Erigeron annuus*), common ragweed (bearing male and female flowers), smartweed (*Polygonum persicaria*), lamb's-quarters, and pansy (escaped from cultivation). Of these the first eight were more or less numerous, while only one or a few individual plants or clumps of the others were observed in bloom. A red raspberry bush bearing ripe and well-formed fruit was found. All the yarrows and evening primroses seen in bloom on this day were plants that had been bent over by the weight of the snow of mid-November and thus protected; and now also were partially sheltered by long, dried grass.

Though from the 25th to the 30th there was but little freezing weather, the mean temperature of only one day was as high as 42°, and there was but little sunshine. The ground was bare, but not frozen. No more evening primroses, bouncing Bets, goldenrods, silvery cinquefoils, beggar ticks, daisy fleabane, or lamb's-quarters were observed in flower after the 25th. On the 30th, however, the rest of the Thanksgiving Day list, as well as one plant of shepherd's purse, doubtless overlooked before, were still in bloom.

On December 5, 1920, a day with mean temperature 40°, from one to a few blooming plants of the following

[1] Acknowledgments are due H. T. Darlington, assistant professor of botany, Michigan Agricultural College, for determining certain plants the specific identity of which was in question.

were observed: Peppergrass, red clover, pansy, yarrow, common ragweed, smartweed, dandelion, and white sweet clover. Chickweed also was common, but scarcely deserves mention, as it is not only one of our hardiest plants, but also one of our few wild everbloomers. Although there occurred days in the first half of December with mean temperature freezing or below, this month brought no severe cold until after the 15th, on which date, however, a snow cover arrived. Thereafter, to the end of the month, from one-half inch to more than 4 inches of snow lay on the ground. Protection from cold, however, no longer served to postpone the time for cessation of blooming. Besides, the pressure of the snow for so long doubtless was not without its ill effects. Consequently, on January 1, 1921, but two species besides the ubiquitous chickweed were found in blossom, namely, dandelion—one head partly open—and peppergrass. The snow cover disappeared on this date, and fresh-appearing foliage—abundant in many instances—of the following plants was noted: Yarrow, dock (Rumex sp.), dandelion, white clover, sweet clover, red clover, evening primrose, narrow-leaved plantain, bouncing Bet, motherwort, hollyhock, chickweed, goldenrod, nettle, mullein, common ragweed, peppergrass, cinquefoil (undetermined species), tall crowfoot, common plantain, and several others.

From January 1 to January 11, 1921, the ground was bare, temperature fell to freezing or below almost every night. The result was that when the tract was next visited, about the middle of the month, only in sheltered spots was any green vegetation to be found.

Notes made in the autumn of 1921 show that while November of that year was almost as mild as November of 1920, a very thick deposit of frost on the 2d, minimum temperature 30°, had a decidedly prejudicial effect upon the vegetation of the tract. Nine species were still in bloom on the 6th, but there was a rapid decline in floral and vegetal activities thereafter. On November 25 a few sickly blossoms of four species were found. These were mallow, yarrow, dandelion, and peppergrass. The state of the foliage of all species was also quite in contrast to that noted on the same date of the previous year. Now, green leaves could be discerned only in unexposed places, whereas in the last week of November, 1920, vegetation was actually flourishing.

Temperature and the snow cover were practically the only meteorological factors considered in these studies. Questions as to flowering and fruiting as controlled by length of day were not taken up. In this connection, however, it is interesting to note the status of asters and goldenrods, which are usually thought of as the very latest of fall flowers. No asters were found in bloom upon the area on the date the study was begun, or thereafter; and goldenrod flowers had ceased to be abundant at that time. Another circumstance bearing on growth as related to length of day is that some ragweeds found on November 25, 1920, were stunted, but bore an abundance of both staminate and pistillate flowers. This ragweed is an annual, and the seeds from which these late plants sprang doubtless had been dropped shortly before and, meeting the proper conditions for germination and growth, had begun to develop. It has been pointed out (see Garner and Allard, Yearbook, Department of Agriculture, 1920) that "late planting * * * may lead to dwarfing in growth but abundant flowering and fruiting."

To return from this digression, and to sum up:

The prolonged activities of wild plants in November, 1920, in the vicinity of Grand Haven, Mich., were due not so much to the mildness of the autumn as to the fact that a snow cover protected vegetation during periods in which the temperature was low enough to destroy exposed plant life.

TEMPERATURE AND THE BLOOMING OF CHERRY TREES.

S. Aoki and Y. Tazika, meteorologists in the Central Meteorological Observatory in Tokio, Japan, have an interesting article in the *Journal of the Meteorological Society of Japan*, April, 1921, on the correlation between the air temperature and the date of blooming of certain cherry trees located in the Observatory grounds.

The period covered by the records is from 1900 to 1921. The average date of blooming is April 2, while the date varied from March 25 in 1913 and 1920 to April 8 in 1917.

The correlation between the mean temperature for 30 days from February 16, and the date of blossoming, gives a coefficient of -0.94, with a probable error of only ± 0.015.

The correlation between the mean temperature for 20 days from February 16 and the date of blossoming, gives a coefficient of -0.80 ± 0.054.

The ability to determine the probable date of blossoming of cherries or other fruit from 10 to 15 days in advance would be of considerable value in making preparation for spraying. The experience in Japan indicates that this will be possible wherever the records of temperature and blossoming dates are long enough to furnish data for calculating the necessary mathematical equations.—*J. W. S.*

RELATION OF TEMPERATURE TO CITRUS SCAB.

The result of some interesting experiments by Prof. H. S. Fawcett in connection with the relation of temperature to infection and growth of the citrus scab fungus is given in the *Journal of Agriculture Research*, May 16, 1921, Vol. XXI, No. 4. In some previous work it was found that abundant moisture was present when bad infection took place, but seasons were encountered when scarcely any infection occurred when moisture and growth appeared to be ideal for an outbreak. Consequently these later experiments were prosecuted to determine what influence the temperature might have.

The tests were made in greenhouse experiments on sour-orange seedlings, with artificially inocculated plants, at temperatures varying from 12° to 42.5° C.

The inocculation temperatures that resulted in infection of growing plants under conditions of rapid growth and abundant moisture were 16°, 18.5°, 19°, 20°, 21° and 23° C. No infection was obtained under the same conditions at temperatures under 16° and above 23° C. Detached leaves floated in water with the scab fungus were infected at 16°, 18.5°, 21°, 24.5°, and 27.5° C.

This limited range of temperature at which infection of a susceptible host took place under the presumably favorable conditions of the experiment appears to explain the great difference observed in the occurrence and serverity of scab from year to year; it also apparently explains the difference of previous inocculation experiments not hitherto understood.

The conditions necessary for scab infection indicated by these experiments are (1) viable spores of the fungus, (2) young citrus leaves of a susceptible species, (3) moisture, and (4) temperatures between 16° and 23° C.—*J. B. K.*

SOIL TEMPERATURE AND WHEAT.

Farmers' Bulletin 1224, "Wheat Scab and its Control," brings out the following facts in connection with the relation of temperature to growth of plants and development of scab.

Wheat seedlings grow best and develop into stocky, healthy plants with a well-developed root system, when the temperature of the soil is about 40° to 60° F. On the other hand, the wheat-scab parasite is a warm-weather fungus, and grows best where the air and soil temperatures are about 70° to 84° F.

The seedling blight develops chiefly from the scabbed kernels sown with the wheat. A warm and comparatively dry soil favors the development of the seedling blight, while a warm, moist air favors rapid growth of the fungus. Warm rainy weather during flowering greatly favors the development of the head blight.

By seeding winter wheat at the latest safe date in the fall, and spring wheat at the earliest safe date in spring, when the soil is moist and cool, with a soil temperature of about 40°, the conditions are most favorable for the development of a good stand of deeply rooted, vigorous wheat seedlings, free from seedling blight. Such plants develop rapidly and mature early.—*J. W. S.*

RELATION OF SOIL TEMPERATURE TO ONION SMUT INFECTION.

Onion smut was first noticed in the Connecticut River Valley in 1869. Since that time it has spread throughout the northern onion growing sections from New York to Oregon, but has not appeared in the southern producing areas of Louisiana and Texas. This segregation of the disease suggested climatic conditions as the principal contributing factor, and some experiments were conducted by Messrs. Walker and Jones, of the Bureau of Plant Industry, to determine the cause of this pronounced geographic distribution of the disease. (See *Journal of Agriculture Research,* Oct. 29, 1921, Vol. XXII, No. 5.)

It was found that some variation in infection occurred with different degrees of moisture, but the moisture conditions did not appear as a serious limiting factor in onion smut infection.

The relation of soil temperature to the development of the host and the parasite was studied under controlled conditions, which gave some very interesting and important results. Seed germinations and growth took place over a range of soil temperature from 10° to 31° C. The most rapid germination and developments of tops occurred with soil temperatures of 20° to 25° C., and the best developments of roots below 20°.

A high percentage of plants grown on smutted soil was infected at soil temperatures ranging from 10° to 25° C. A decided reduction in infection was noticed at about 27°, and complete freedom from the disease resulted at 29°. The air temperature was uniformly from 15° to 20° C.

Successive out-of-door plantings at Madison, Wis., made in inoculated soil during the growing season, resulted in a gradual reduction of infection as the season advanced and the soil temperature rose. Complete freedom from smut was attained when the daily mean soil temperature at 1 to 2 inches depth remained at or slightly above 29° C. for two or three weeks. There was also a tendency, as the temperature rose, for the seedlings to outgrow the disease by the sloughing off of the diseased cotyledons before infection of the first leaf occurred.

It appears that the regional distribution of onion smut in the United States is conditioned upon the soil temperature during the seedling stage of the plant's growth, the infection and development of smut being favored by the relatively low temperatures and inhibited by the high temperatures, with approximately 29° C. as the critical point.—*J. B. K.*

HEAVY SNOWSTORM IN SOUTHERN MICHIGAN, NOVEMBER 8-9, 1921.

D. A. SEELEY, Meteorologist.

[Weather Bureau, Lansing, Mich., Dec. 23, 1921.]

The heaviest snowstorm ever recorded in this vicinity occurred November 8 and 9, 1921. The total fall at Lansing was 18.9 inches in less than 36 hours.

The storm was not only unusual as to the amount of snowfall, but also from the fact that it came so early in the season. Previous to this storm there was no record of any snowfall in November exceeding 10 inches.

The snowfall, as shown on the accompanying chart, was heaviest in this immediate section. A strip about 50 miles wide extending from east to west across the south-central part of the State was the only section where the snowfall was heavy. In the northern parts of the Lower Peninsula none was recorded and there was but little in the southern tier of counties.

The weather map on the morning of November 7 indicated the development of a low-pressure area over Colorado. The pressure was high from Lake Superior westward. During the following 24 hours the Colorado LOW moved eastward and was central on the morning of the 8th over northern Missouri, whence it moved slowly up the Ohio Valley. Snow began falling at Lansing at 10:00 p. m. on the 7th, although the center of the low area was still well to the southwestward with clear weather in the Ohio and Mississippi Valleys. Snow continued heavily all day on the 8th, with the temperature slightly below freezing. Meanwhile the high-pressure area moved southeastward over the trans-Mississippi region.

The weather map seems to indicate that moisture for the heavy snowfall was furnished by outflowing upper currents from the low-pressure area to the southwest. Temperatures were high near the storm center and moderately low in the Lake Superior region, in connection with the high pressure. The probability is that this cold air moving in from the north at the surface and mixing with the warm and moist air outflowing from the low-pressure area above produced the large amount of snowfall.

The pilot-balloon observation made at this station on the afternoon of November 7 showed a backing of the wind from north at the surface to west at elevation of 1,350 meters, where heavy St.-Cu. clouds were entered. This rather supports the theory in regard to the sources of moisture just mentioned.

The distribution of snowfall in Lower Michigan is shown by figure 1.

DISCUSSION.

By A. J. HENRY.

The phenomenon described by Mr. Seeley is of more general occurrence than might be supposed; it falls within the class of what might be called islands of greater

rainfall occurring within large areas of light and moderate rains. The best examples are found in the Gulf States and may be looked for in practically all seasons, although more common in the cold than in the warm season. This uneven distribution is common to both tropical and extra-tropical cyclones.

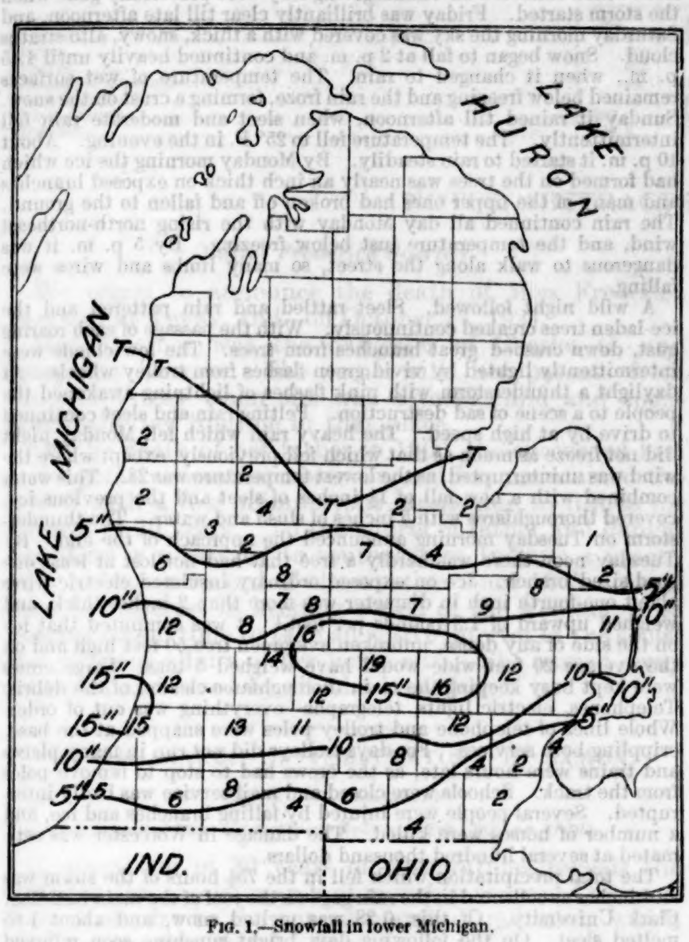

FIG. 1.—Snowfall in lower Michigan.

The source of the moisture is, of course, easy to fix, but the cause of the uneven distribution is not so easy to explain. It can not be due to surface relief because along the Gulf coast there is no surface relief worth mentioning.

In the absence of cloud or pilot-balloon observations it is not possible to determine the direction of the free-air winds over the regions of heavy rainfall, but there is every reason to believe that they are from the Gulf. In the cold season the air temperature at 3 km. level may be, and probably is, higher over the Gulf than it is over the adjacent continental area at the same level. The warmer air would then override the colder air and thus general precipitation would result. But would this be the case in tropical cyclones in which excellent examples of irregular distribution of precipitation may be found? Nothing is known of the temperature distribution in tropical cyclones. It would therefore be hazardous to place them in the same category with extra-tropical cyclones.

In the case discussed by Mr. Seeley, pilot-ballon observations made in the afternoon of the day before the snow storm show that southerly winds prevailed up to 3 km. and higher over a large area extending from Texas northeastward to the Great Lakes. That this presumably warm current from the southwest was underrun by a cold northerly current having its origin in the Lake Superior region appears to be the explanation of the heavy snowfall over Lower Michigan as shown in figure.

TORNADOES OF NOVEMBER 17, 1921, IN ARKANSAS.

By W. C. HICKMON, Observer.

[Weather Bureau, Little Rock, Ark., Dec. 9, 1921.]

SYNOPSIS.

Two tornadoes occurred in Arkansas during the late afternoon and evening of November 17, 1921, in which 11 people were killed, 39 or more injured, and nearly $20,000 worth of property destroyed. The first tornado occurred in southern Polk County and followed a west-east course; the other, starting in Clark County, moved northeastward across Hot Springs County into the southeast edge of Garland County. Both were very destructive when touching the earth; fortunately the funnel cloud seems not to have been in contact with the earth at all times, but lifted from place to place.

Preceding and attending weather.—The morning weather map of November 17 showed low pressure covering the Mississippi Valley and the Southwest, with the principal centers over Illinois and northeastern Arizona; high pressure overlay the Canadian maritime provinces and the northwestern border. The horizontal temperature gradient was steep from Kansas to Arkansas and Texas. In the evening the map showed the Arizona LOW to have increased in intensity. It was centered over New Mexico, with a trough extending northeastward across Arkansas to the Lakes, the HIGH in the Northwest moving in from the North Pacific. The temperature gradient continued steep. The pressure distribution, the marked difference in temperature over a small area of the country, and the location of the trough, all combined, made a condition favorable for the formation of tornadoes in Arkansas.

Probably two tornadoes.—While it is not absolutely certain that there were two tornadoes in Arkansas during the afternoon and evening of November 17, the fact that the first damage occurred in Polk County near 5:00 p. m. and the other did not occur until 8:30 p. m. leads us to believe that the two were separate storms. No trace of a destructive storm was found between southern Polk County and Clark County, so the two are mentioned separately.

The Polk County tornado.—The first and only serious damage done by the tornado in Polk County occurred about 1 mile west of Wicks when the home of R. E. Weems was totally destroyed and its eight occupants killed, their bodies being strewn along the storm's path, one being fully one-half mile from the place where the house stood.

Clark, Hot Springs, Garland County tornado.—Starting in sec. 31, Twp. 6 S., R. 20 W., in Clark County, and moving in a northeastward direction over a path varying in width from one-fourth to three-fourths mile, another tornado occurred which killed three people, injured 37, and did considerable property damage.

This tornado did not have a complete path from the lumber camp near De Gray to Lonsdale, but the direction of its movement and the time of its occurrence indicate that it was one and the same storm. Like the one in Polk County, the funnel-shaped cloud touched the earth only occasionally, but left destruction wherever it touched.

The Garysonia Lumber Co.'s logging camp, near De Gray, Clark County, was struck about 8:30 p. m. and was torn to shreds by the storm's fury, only splintered timbers remaining of the shacks and boarding cars in which the lumbermen and their families lived. In this

camp 1 woman was killed and 30 or more people were injured. It is estimated that 2,000,000 feet of timber was blown down, of which at least a third will be a total loss.

An unusual feature of the storm noted in this section was the absence of rain during its passage. A great glow lighted up the sky as the storm approached, and heavy hail was reported to the northwestward, but with the storm itself there was no precipitation.

Near Magnet Cove, Hot Springs County, one man was killed and four other members of his family were injured. In this neighborhood the storm cut a swath nearly a mile wide, twisting the timber and doing much damage to homes and other buildings. A little farther northeastward in Garland County another life was lost, this being the last loss of life reported.

Two years ago the Magnet Cove community was visited by a heavy wind, and this tornado seems to have followed almost the exact path made two years ago.

Heavy precipitation.—The passing of the LOW in which these tornadoes occurred brought excessive rains in Arkansas the 16th, 17th, 18th, and 19th.

GREAT ICE STORM OF NOVEMBER 26-29 IN MASSACHUSETTS.

A shallow barometric depression (30.10 inches) developed during the night of the 26th-27th over the Atlantic directly south of Nantucket. This depression was formed in a bend of the isobar of 30.20 inches surrounding an anticyclone (30.50 inches) central over the mouth of the St. Lawrence. The gradients were therefore for northeast to north winds over New England, with rain and snow, depending upon the temperature. The northern HIGH gave way somewhat during the 27th, and by the morning of the 28th a large cyclone with central pressure 29.50 inches in southwestern Virginia occupied practically the whole of the New England and Middle Atlantic States and the western portion of the Canadian maritime provinces. By this time the snow of the first depression had changed to rain, which was general from Virginia to the Maine coast, snow falling only in the interior of Maine. The Virginia cyclone moved northeastward to the Atlantic south of New England by the morning of the 29th, and continued in a course to the northeast over the Atlantic. So much for the weather maps during the storm period. The following is quoted from a letter to the editor from Mr. Royal Robbins, Boston, Mass.:

The storm caused a snowfall of over 2 feet in northern New England, and heavy rain with some snow in the southern portion of New England. Over an area of perhaps 3,600 square miles, 60 miles west and north from Boston, this heavy rain froze as it fell for parts of three days, resulting in the most severe ice storm within living memory. Rain fell for many hours, with a temperature of 26° (F.) and a total precipitation of more than 3 inches of rain.

Over this large area, chiefly in northeastern Massachusetts, where the rain froze as it fell, the damage probably exceeded that of any storm on record in the same territory. The loss to telegraph, telephone, and electric lighting companies is estimated at over 5 million dollars, while more than 100,000 trees were ruined. The value of the latter is difficult to compute, but would probably reach 5 or 10 million dollars more. The loss of this great number of beautiful trees in cities and towns is irreparable.

While several gales occurred off the coast, the winds in the ice area did not exceed 30 miles per hour, so that the actual weight of ice was the chief cause of the great damage. The weight on the wires is said to have been about 2 tons between telegraph poles, 2,700 of which poles fell on one railroad in the 60 miles immediately west of Boston. The area of destruction was bounded on the north by the region where the precipitation was entirely snow; and on the south and west by the region where the rain did not freeze.

Dr. C. F. Brooks and Mr. G. F. Howe, writing in the *Bulletin of the American Meteorological Society*, give the following account of the storm as experienced at Worcester, Mass.:

Even the "oldest inhabitant" admits the ice storm of November 26-29 was the worst that has been known in this section. The ice and sleet which collected on Thanksgiving Day were practically gone when the storm started. Friday was brilliantly clear till late afternoon, and Saturday morning the sky was covered with a thick, snowy, alto-stratus cloud. Snow began to fall at 2 p. m. and continued heavily until 4:45 p. m., when it changed to rain. The temperature of wet surfaces remained below freezing and the rain froze, forming a crust on the snow. Sunday it rained till afternoon, when sleet and moderate rain fell intermittently. The temperature fell to 25° F. in the evening. About 10 p. m. it started to rain steadily. By Monday morning the ice which had formed on the trees was nearly an inch thick on exposed branches and many of the upper ones had broken off and fallen to the ground. The rain continued all day Monday with the rising north-northeast wind, and the temperature just below freezing. By 5 p. m. it was dangerous to walk along the street, so many limbs and wires were falling.

A wild night followed. Sleet rattled and rain pattered and the ice-laden trees creaked continuously. With the passage of each roaring gust, down crashed great branches from trees. The low clouds were intermittently lighted by vivid green flashes from trolley wheels. At daylight a thunderstorm with pink flashes of lightning awakened the people to a scene of sad destruction. Pelting rain and sleet continued to drive by at high speed. The heavy rain which fell Monday night did not freeze as much as that which fell previously, except where the wind was uninterrupted, as the lowest temperature was 28. This water combined with a new fall of 1½ inches of sleet and the previous ice, covered thoroughfares with 5 inches of slush and water. The thunderstorm on Tuesday morning announced the approach of the end. By Tuesday noon there was hardly a tree that had not lost at least one good-sized branch. Ice on exposed ordinary insulated electric wires about one-fourth inch in diameter was more than 2 inches thick, and weighed upward of 1.3 pounds per foot.[1] It was computed that ice on the side of any dense, unbroken evergreen tree 50 feet high and on the average 20 feet wide would have weighed 5 tons. Large crews were kept busy keeping the main thoroughfares cleared of the débris. Telephones, electric lights, telegraphs—everything was out of order. Whole lines of telephone and trolley poles were snapped at the base, crippling both services. For days trolleys did not run in many places and trains were hours late, as the crews had to stop to remove poles from the track. Schools were closed and mail service was badly interrupted. Several people were injured by falling branches and ice, and a number of horses were killed. The damage in Worcester was estimated at several hundred thousand dollars.

The total precipitation which fell in the 75½ hours of the storm was 4.05 inches as collected in the rain gage on the roof of the main building, Clark University. Of this, 0.28 was melted snow, and about 1.65 melted sleet. On the following day, bright sunshine soon relieved unbroken branches of some of their load of ice, though not without first inflicting further damage to some trees by expanding the ice on overweighted limbs.

The unusual duration of this ice storm seems to have been due to a large supply of cold air flowing southwards, and of warm air going northwards above it. The cold wind at the surface, as is usual when sleet or ice storms occur, formed a barrier over which the warm wind had to rise. It was this rising and the consequent cooling by expansion which reduced the vapor capacity of the wind aloft and thus produced rainfall. The two currents in this case were surprisingly well balanced. The temperature of the lower one did not rise enough above freezing to prevent the continued formation of ice, while the wind above, after the first fall of snow, remained continuously so much above freezing that all the precipitation from it was in the form of rain.

It was interesting to note that the conditions which gave the big ice storm here also caused very severe ice storms in Oregon and Washington on November 20 and 21, said to be the worst since 1916, and destroyed thousands of orchard trees.

—*A. J. H.*

ANALYSIS OF SUMMER PRECIPITATION AT MOUNT VERNON, IOWA.

By W. A MOORE and DONALD CORLETT.

[Cornell College, Mt. Vernon, Iowa.]

The following table gives the results of chemical analyses of rains which fell at Mount Vernon, Iowa, during the summer of 1921, in parts per million.

[1] A piece of ice 9.5 inches long, which had fallen from an electric wire on the south side of Coes Pond, was picked up on the morning of Dec. 11. It weighed exactly 1 pound The ice was 1.8 to 2 inches thick and 2.3 to 2.6 inches wide.

Date	June 20 (night).	June 25 (night).	June 27 (a. m.).	June 27 (p. m.).	July 4 (p. m.).	July 14 (night).	July 18 (a. m.).	July 28 (night).	Aug. 1 (day).	Total.
Wind direction	E.	E.	E.	E.	SE.	SE.	SE.	E.	NE.	Total.
Total precipitation (in.)	0.25	0.42	0.90	0.30	0.22	0.49	0.77	0.10	1.53	....
Alkalis	210.	16.0	184.0	18.0	4.60	154.23	18.00	None.	116.0	720.83
Chlorine	14.2	17.5	16.3	14.25	14.26	7.10	13.40	17.75	14.2	128.96
Nitrites	.006	.004	.004	.004	.01	.011	Trace.	Trace.	Trace.	.039
Nitrates	.055	.05	.04	.06	.04	.03	.06	.01	.001	.346
Albuminoid ammonias	.02	27.0	28.00	8.00	18.60	10.80	14.00	....	4.80	92.62
Free ammonias	.40	11.0	12.00	3.00	14.20	8.40	1.36	....	1.10	52.26
Carbon dioxide	200.	16.0	26.4	53.60	42.40	29.40	69.60	19.50	26.25	483.15
Sulphates	118.8	75.20	52.60	60.04	5.30	72.70	283.40	23.00	25.00	616.04

NOTES, ABSTRACTS, AND REVIEWS.

Miss Frederica Boerner.

We regret to announce the death of Miss Frederica Boerner, at Vevay, Ind., on October 27, 1921.

Miss Boerner was the daughter of Charles G. and Josephine Boerner. She came with her parents from Ohio to Vevay when she was a mere child and spent practically her lifetime in that place.

On the death of her father in 1900, she succeeded him as cooperative weather observer, and has maintained the record with a few unimportant lapses due to illness for upward of 20 years. To the efforts of father and daughter, there is preserved to southeastern Indiana a practically unbroken record of the weather since 1865. Aside from her interest in keeping watch of the weather, Miss Boerner found time to take an active interest in the social and religious affairs of her home city. She passed away respected and loved by all who knew her.

ANNUAL MARCH OF TEMPERATURE IN SAMOA.

By G. ANGENHEISTER.

[Abstracted from *Meteorologische Zeitschrift*, Feb., 1921, pp. 47-50.]

A discussion of 30 years of observations reveals the fact that the annual march of monthly means of temperature is similar to the annual march of radiation, which may be computed by the formula

$$J=J_0(d''/960'')^2\int \sin h\ dt,$$

where h is the altitude of the sun, t the hour angle of the sun, and d the apparent radius of the sun in seconds of arc. The integral has to be computed between sunrise and sunset. If the atmospheric extinction is taken into account, the above formula becomes

$$J=J\ (d''/960'')^2\int q^{\frac{1}{\sin h}} \sin h\ dt,$$

where q is the extinction coefficient. As extinction does not appreciably change the character of the curves, we can disregard it.

The temperature follows radiation,[1] their apparent difference in phase being equal to from one-half to one month. They both show a deep minimum in the middle of the year and a flat maximum at the beginning. Although the sun crosses the zenith of Samoa twice a year (Oct. 30, and Feb. 12), the daily amount of radiation shows only one maximum in January because of the variation of the length of the day. When the radiation in Samoa diminishes about 1 per cent, the mean monthly temperature (with a retardation of one month as stated above) decreases about 0.0273°C. This coefficient varies at different places on the earth's surface. Knowing this coefficient and the mean temperature of one month for a certain station, it is possible to compute with great accuracy the annual march of temperature from the annual march of radiation.[2]

It is understood that such a simple relation is to be expected only in the uniform areas of tropical oceans. For Samoa, the difference between the computed temperature and the observed one is less than 0.1°C. The mean annual amplitude (observed) in Samoa is 1.1°C. The result of the investigation of the relation between the annual march of radiation and temperature is the following: Island stations damp the influence of short-period variations of radiation, while the long-period variations, although of small amplitude, are very well expressed. The contrary is observed at the land stations.

Maximum temperature occurs in Samoa shortly after noon. For two or three hours after that time, the temperature hardly changes, the average change being no more than 0.01°C.—*J. P.*

[1] The author is here evidently considering changes in radiation due to the changing declination of the sun,—not to changes in the intensity of solar radiation.—EDITOR.

CITRUS CROP INSURANCE IN FLORIDA.

The following excerpts from the *Florida Grower* and the Tampa *Tribune* will be of interest in connection with the question of crop insurance as a possible substitute for the expensive smudging operations against frost:

Crop insurance is here at last. A Philadelphia firm * * * representing several big fire insurance companies is now prepared to write frost insurance on citrus crops. As I understand it [the representative] will write policies on individual groves or an association may take out a blanket policy on the crop of all its members. No provision is made for insuring trees, though that may come another year; it is being considered. Insurance applies only to fruit actually on the trees at time of damage and does not include injury to bloom, the policy automatically expiring on March 15. No policy goes into effect until 72 hours after it has been written. I presume this latter is to forestall applications that might be made at a time when a freeze may have been predicted by the Weather Bureau. Insurance will be confined to the south of the northern borders of Volusia, Marion, and Citrus Counties. Rates will be on a sliding scale, water protection having an influence in the rate making. The lowest rate will be 6 per cent and from that up to 8½ per cent, the insurance agent to be the judge as to the frost danger.

Great interest will no doubt be aroused among the growers at this announcement. Florida should feel honored that the plan is to be tried out here first. California will probably be considered another

[2] This study of the relation between the annual march of temperature in Samoa and the annual march of radiation is a specific example of a problem which was treated in a more general way for the whole earth by Angot, in *Annales du Bureau Central Météorologique de France*, for the year 1883, pp. B121-B169, in a paper entitled *Recherches théoretiques sur la distribution de la chaleur à la surface du globe*. The paper begins with a general bibliographic discussion, and proceeds to the development of formulae which give the heat received at the outside of the atmosphere in different seasons; next the question of atmospheric absorption is treated and the heat received at the surface with different degrees of atmospheric transparency discussed. The formula used by Angenheister above appears in essentially the same form in Angot's paper. A more detailed discussion follows in which the amount of heat received annually at each latitude from the equator to the poles, by ten-degree intervals, the heat received on the same day in different latitudes, and the total heat received during the year at different latitudes, are treated. The work is important and forms a substantial foundation for studies similar to that carried out by Angenheister.—*C. L. M.*

year. The plan has infinite possibilities in the safeguarding of a citrus investment, and no doubt in the future mortgagees will insist that a crop be insured and when the time comes that the companies will consider tree insurance citrus property will take its place as security along with other real estate securities; stabilizing the industry; possibly making Government farm-loan funds more available.—*Florida Grower*, Nov. 28, 1921.

ARCADIA, Nov. 21.—The first frost insurance policy ever written in this city was written here Monday in favor of the Arcadia Citrus Exchange branch of the county organization for the amount of $75,000 to cover this year's crop from frost or freeze. The premium is 10 per cent of the gross amount of the insurance carried and will cost the grower members of the exchange $7,500, which is divided pro rata on the box basis, and will cost the 250 members 3 cents per box, basing the estimate on a normal crop.—*Tampa* (Fla.) *Tribune*, Nov. 28, 1921.

ATMOSPHERIC ELECTRICITY AND THE MOVEMENT OF DEPRESSIONS.[1]

By J. LACOSTE.

[Abstracted from *Comptes Rendus*, Nov. 7, 1921, pp. 843-845.]

Studies made during the summer of 1921 at the Geophysical Institute of Strasbourg, on radiogoniometry, have led to interesting meteorological relations between the direction of maximum intensity of "strays" and the movement and shape of depressions. The author has stated four tentative laws concerning this relation:

1. In the case of a well-defined circular depression, the maximum intensity of strays is observed in the direction of the southern or southeastern part of the depression; the change of this direction of maximum intensity serves to follow the movement of the depression.
2. In the case of an elliptical depression, less well marked, the maximum intensity, as in the first case, is observed to come from the southern or southeastern parts. This case is less satisfactory than the first.
3. In the case of secondary depressions, or the barometric fluctuations along squall fronts, the maximum is difficult to determine.
4. A squall close at hand gives violent strays.

These observations have permitted the author to follow the movements of known depressions, and also to forecast the arrival of those as yet unseen on the weather map. He also found a striking relation between observations of maxima in 1920 and the corresponding barometric distribution. This, he believes, points the way to a new viewpoint in the forecasting of weather.—*C. L. M.*

ARTIFICIAL PRODUCTION OF RAIN.

By DR. HAROLD JEFFREYS.

[Reprinted from *Nature*, London, Nov. 3, 1921, pp. 313-314.]

In an article in the *Times* of October 17 an account is given of the achievements of Mr. Charles M. Hatfield in producing rain. The method used is not described in any detail. A tank filled with certain unspecified "chemicals" was exposed at a height of 25 feet above the ground, and it is claimed that this had the effect of producing 8 inches of rain in three months at Medicine Hat, 22 miles away. The theory of the method is that the apparatus draws clouds from other parts to the Medicine Hat district and causes them to precipitate their moisture there. No direct observations of the motions of clouds are mentioned in confirmation of this theory, though they should not have been difficult to obtain.

[1] Sur la relation existant entre les directions des dépressions et les directions des maximums des parasites atmospheriques.

The official raingage at Medicine Hat during May, June, and July, the period of the contract, recorded 4.8 inches, which was 1.3 inches below the normal for the station for those months. Further comment on the success of the experiments is unnecessary.

The financial side of Mr. Hatfield's contract with the United States Agricultural Association of Medicine Hat is interesting, for the association was apparently prepared to pay Mr. Hatfield as if 8 inches of rain had fallen. Still more interesting is the fact that he was promised $4,000 for 4 inches and $6,000 for 6 inches. Since the normal rainfall is 6.1 inches Mr. Hatfield would have been much more likely than not to make a substantial profit even if he had done nothing at all.

It may be mentioned that at Calgary, Alberta, the rainfall was 3 inches below normal; at Edmonton, it was 3.1 inches above; and at Qu'Appelle, Saskatchewan, 300 miles to the east, it was 3.85 inches above normal.

It is also stated that at Los Angeles, in the first four months of 1905, Mr. Hatfield guaranteed 18 inches of rain, and that his own raingage showed 29.49 inches. If this is correct the rainfall must have been extremely local, for the official raingage at Los Angeles in those months, showed only 14.98 inches. Still, this was 4.4 inches above normal. At San Diego, however, which is 200 miles away, the excess was 4.6 inches, and it appears likely that the abnormality at both stations was due to more widespread causes than Mr. Hatfield's chemicals.

Attempts have on many previous occasions been made to produce rain by artificial means, but the results have been uniformly unsuccessful. The reason is not difficult to see. To make the water vapor in the air condense it is necessary to cool the air in some way to a temperature below the dew point. This may be done in two ways. One may cool the air directly, for instance by the evaporation of liquid carbon dioxide or liquid air. This certainly would produce a little condensation; the fatal objection to it is that it would be thousands of times cheaper to distil sea water. The other method is to raise the air. The pressure decreases with height, and to reduce the pressure on a particular mass of air is known to cool it. The difficulty is to raise it enough. To produce an inch of rain over an area of 100 square miles requires the condensation of 6,000,000 tons of vapor, and to achieve this some hundreds of millions of tons of air must be lifted up. The distance it must be raised depends on how nearly saturated it was originally, but it could not be less than a kilometer in ordinary fine weather conditions. We have no source of energy at our command great enough to achieve this.

It is often suggested that rain may be produced by exploding shells or otherwise agitating the air. The action is compared with that of a trigger, a large amount of energy being released by a small effort. An essential feature is, however, overlooked. For a trigger to work, there must be a large supply of potential energy only awaiting release. Precipitation from partially saturated air would require an actual supply of new energy. Therefore a trigger action can not produce precipitation.

Apropos of the above, the following account of rainmaker Hatfield's exploit in the State of Washington is not without interest:

* * * * *

The people of Washington have taken a lively interest in the efforts of a professional rainmaker near Moses Lake, who was engaged by the Commercial Club of Ephrata to arrange for enough precipitation to insure bountiful crops this summer. Hundreds of visitors, bitten by

the curiosity, have gazed upon the curious tower from which mysterious gases were supposed to flow into the atmosphere. As a sporting proposition the attempt of the rain maker was not without public interest; if he produced rain he was to receive adequate remuneration, but if he failed he was to have nothing but the inexpensive good wishes of the community. Now the rainmaker has gone and almost immediately the skies open up and discharge their heavy load of moisture. Skeptical persons may refuse to see any connection between the mysterious "forces" loosed by the rainmaker and the cloudbursts in eastern Washington, but the miracle man, it appears, is able to recognize the storms as his own. Especially, he avers, does the rainfall at Ephrata have his private brand, although its arrival was somewhat late.—* * * *Post Intelligencer*, Seattle, Wash., July 17, 1920. Reprinted from *Bulletin American Meteorological Soc.*, Aug. 1920, pp. 80-82.

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SOLAR OBSERVATIONS.

SOLAR AND SKY RADIATION MEASUREMENTS DURING NOVEMBER, 1921.

By HERBERT H. KIMBALL, Meteorologist.

For a description of instruments and exposures, and an account of the method of obtaining and reducing the measurements, the reader is referred to this REVIEW for April, 1920, **48:** 225.

Table 1 indicates that solar radiation intensities averaged slightly above the November normal at Washington, D. C., and Santa Fe, N. Mex., and slightly below at Lincoln, Nebr. At Madison, Wis, there were only two days with an average cloudiness below 60 per cent, and in consequence few solar radiation intensity measurements were made. Table 2 shows that the total radiation received on a horizontal surface was below the normal for November at both Washington and Madison, the deficiency at each station amounting to about 17 per cent.

Skylight-polarization measurements made on four days at Washington give a mean of 64 per cent and a maximum of 70 per cent on the 25th. At Madison, measurements obtained on the 4th give 71 per cent of polarization. The measurements obtained at Washington are average values for November at that station.

TABLE 1.—*Solar radiation intensities during November, 1921.*

[Gram-calories per minute per square centimeter of normal surface.]

Washington, D. C.

Date.	8 a.m. 75th meridian time.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon. Local mean solar time.
		Air mass. A. M.					P. M.				
	e.	5.0	4.0	3.0	2.0	*1.0	2.0	3.0	4.0	5.0	e.
	mm.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	mm.
Nov. 5	3.45			1.10	1.29				0.88	0.75	3.00
10	6.76		0.80	0.96							3.81
15	4.75	0.59		0.93	1.12		1.10		0.62		3.99
16	3.63		0.49								4.95
18	10.59				1.11						12.68
22	5.56		0.89	1.08	1.31	1.56	1.27	1.00	0.90	0.79	7.04
25	3.99					1.54	1.31	1.11	0.93	0.79	3.63
30	4.17	0.69									5.16
Means		(0.64)	0.73	1.02	1.21		1.23	(1.06)	0.83	0.78	
Departures		−0.12	−0.12	+0.01	+0.03		+0.06	+0.08	+0.01	+0.05	

Madison, Wis.

Date.	8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon.
Nov. 1	2.49						1.40				4.17
4	5.36			1.16	1.29						5.16
29	4.57				1.18						4.57
Means				(1.16)	(1.24)		(1.40)				
Departures				+0.01	−0.05		+0.05				

TABLE 1.—*Solar radiation during November, 1921*—Continued.

Lincoln, Nebr.

Date.	8 a.m. 75th meridian time.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon. Local mean solar time.
		Air mass. A. M.					P. M.				
	e.	5.0	4.0	3.0	2.0	*1.0	2.0	3.0	4.0	5.0	e.
	mm.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	mm.
Nov. 1	4.37		1.04	1.14	1.36		1.35	1.22	1.04		5.16
9	3.00	0.90	0.93	1.08							3.45
11	2.62						1.44	1.25			3.15
19	2.16			1.08	1.31						4.17
24	2.62	1.00	1.13	1.25	1.39			1.13			2.87
Means		(0.95)	1.03	1.12	1.35		(1.40)	1.20	(1.04)		
Departures		−0.03	−0.03	−0.09	−0.01		+0.01	−0.01	−0.02		

Santa Fe, N. M.

Date.	8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon.
Nov. 22	1.78							1.43	1.28		2.36
23	2.62						1.44	1.28	1.18		1.88
26	3.63	1.15	1.21	1.39	1.50	1.62		1.37	1.19		3.15
28	1.88	1.19	1.29	1.38	1.48						2.36
Means		(1.17)	(1.25)	(1.38)	(1.49)		(1.44)	1.36	1.22		
Departures		+0.01	+0.04	+0.02	+0.02		−0.02	+0.04	+0.02		

*Extrapolated.

TABLE 2.—*Solar and sky radiation received on a horizontal surface.*

Week beginning.	Average daily radiation. Washington.	Madison.	Lincoln.	Average daily departure for the week. Washington.	Madison.	Lincoln.	Excess or deficiency since first of year. Washington.	Madison.	Lincoln.
	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.
Oct. 29	157	171		−95	−17		+2,701	−3,097	
Nov. 5	225	160		−6	−12		+2,656	−3,181	
12	190	99		−18	−54		+2,533	−3,560	
19	162	92		−25	−46		+2,355	−3,881	
26	108	69		−61	−50		+1,929	−4,293	

MEASUREMENTS OF THE SOLAR CONSTANT OF RADIATION AT CALAMA, CHILE.

By C. G. ABBOT, Assistant Secretary.

[Smithsonian Institution, Washington, January —, 1922.]

NOTE.—In the December issue of this REVIEW, the publication of the reports from Calama, Chile, will be resumed and brought down to date.—EDITOR.

WEATHER OF NORTH AMERICA AND ADJACENT OCEANS.

NORTH ATLANTIC OCEAN.

By F. A. YOUNG.

The average pressure for the month was considerably lower than usual at St. Johns, Newfoundland, while at all other land stations on the American coast it was not far from the normal, the same conditions holding true at the Azores, Bermudas, and British Isles; except at Lerwick, Scotland, and London, England, where the departures were positive.

Comparatively few reports of fogs were received from vessels in the vicinity of the Grand Banks and steamer lanes, while it was observed frequently at land stations in Great Britain.

The number of days with winds of gale force was somewhat greater than usual; especially over the central and western sections of the ocean.

On the 1st there was a fairly well-developed LOW of limited extent in mid-ocean, with moderate gales between the thirty-fifth meridian and coast of Newfoundland. Storm log follows:

American S. S. *City of Philadelphia:*

Gale began on the 1st, wind SSE. Lowest barometer 29.24 inches at 6 a. m. on the 1st, wind SSE., in latitude 46° 15′ N., longitude 39° 32′ W. End on the 1st, wind SSE. Highest force of wind 8, SSE.; steady from SSE.

This disturbance moved in a northeasterly direction, gradually increasing in force, as on the 2d only light to moderate winds were reported, with fog in the southeast quadrants. On the 2d, Halifax, Nova Scotia, was near the center of a second LOW, which moved very slowly toward the northeast, reaching a point near St. Johns, Newfoundland, on the 4th. On the 5th and 6th it remained nearly stationary, increasing in force, and on the latter date the storm area extended between the thirty-fifth and fiftieth parallels, west of the fifty-fifth meridian. On the 6th there was also a disturbance off the British coast. Storm logs follow from vessels in different localities, and covering the period from the 2d to the 7th.

Belgian S. S. *Kremlin:*

Gale began on the 1st, wind SW. Lowest barometer 29.67 inches at 9 p. m. on the 1st, wind SW., 9, in latitude 39° 19′ N., longitude 63° 52′ W. End on the 4th. Highest force of wind, 10; shifts NW.-SW.

American S. S. *Finland:*

Gale began on the 4th, wind SE. Lowest barometer 29.32 inches at 4.30 p. m. on the 4th, wind SE., 7, in latitude 42° 49′ N., longitude 56° 38′ W. End 7 p. m. on the 4th, wind NNW. Highest force of wind, 9; shifts SE.-NNW.

British S. S. *Kabinga:*

Gale began on the 5th, wind W. Lowest barometer 29.63 inches at midnight on the 5th, wind NW., 10, in latitude 40° 02′ N., longitude 58° 35′ W. End on the 6th, wind WNW. Highest force of wind, 10, NW.; shifts SSW.-W.-NW.-WNW.

Norwegian S. S. *Ranenfjord:*

Gale began on the 5th, wind SE. Lowest barometer 29.38 inches at 1.30 a. m. on the 6th, wind SW., 10, in latitude 50° 18′ N., longitude 46° 24′ W. End midnight on the 6th, wind SW. Highest force of wind, 10; steady from SW.

American S. S. *Mount Clay:*

Gale began on the 6th, wind NW. Lowest barometer 28.78 inches at midnight on the 6th, wind NW., 10, in latitude 52° 56′ N., longitude 4° 05′ E. End on the 7th, wind NW. Highest force of wind, 11, NW.; steady from NW.

On the 8th still another disturbance appeared off the Newfoundland coast, which was, however, of moderate intensity and extent; this moved rapidly northeastward, and on the 10th the center was apparently not far from Iceland. On the 10th there was a LOW off Nantucket that moved slowly up the coast, and on the 11th it was near St. Johns, Newfoundland; it then curved toward the east, and moving rapidly, was in British waters by the 13th. Storm logs follow:

British S. S. *Kenbane Head:*

Gale began on the 8th. Lowest barometer 28.72 inches at 4 p. m. on the 8th, wind N., 10, in latitude 53° N., longitude 50° W. End at noon on the 10th. Highest force of wind, 10; shifts, 2 points (at intervals).

French S. S. *Roma:*

Gale began on the 10th, wind SE. Lowest barometer 29.84 inches at 5.44 p. m. on the 10th, wind SW., 9, in latitude 37° 44′ N., longitude 59° 08′ W. End on the 11th, wind WSW. Highest force of wind 9, SW.; steady from SW.

British S. S. *Alpine Range:*

Gale began on the 10th, wind SE. Lowest barometer 29.20 inches at 4 p. m. on the 11th, wind NW., 9, in latitude 50° 20′ N., longitude 46° W. End on the 12th, wind NW. Highest force of wind, 10; shifts SW.-NW.-W. by N.

Dutch S. S. *Nieuw Amsterdam:*

Gale began on the 12th, wind SSW. Lowest barometer 29.46 inches at 4 p. m. on the 13th, wind WSW., 11, in latitude 47° 56′ N., longitude 36° 42′ W. End on the 15th, wind NW. Highest force of wind, 12, WSW.; shifts WSW.-NW.

American S. S. *Quistconck:*

Gale began on the 12th, wind SSW. Lowest barometer 29.39 inches on the 12th, wind SSW., 10, in latitude 55° 06′ N., longitude 14° 30′ W. End on the 13th, wind SSW. Highest force of wind, 10, SSW.; steady from SSW.

Belgian S. S. *Eglantier:*

Gale began on the 12th, wind S. Lowest barometer 29.11 inches at 4 a. m. on the 15th, wind SSW., 9, in latitude 51° 15′ N., longitude 21° 10′ W. End on the 17th, wind SSW. Highest force of wind, 10; shifts SSW.-WSW.-W.-WNW.

Charts IX, X, XI, and XII show the conditions on the 14th, 15th, 16th, and 17th, respectively, when the greater portion of the steamer lanes was swept by heavy gales, which on the first three days extended to the British coast. Storm logs follow:

American S. S. *Glen Ridge:*

Gale began on the 13th, wind SW. Lowest barometer 29.68 inches on the 16th, wind S., 10, in latitude 48° N., longitude 32° W. End on the 16th, wind SW. Highest force of wind 10, S.; shifts S.-WSW.

American S. S. *W. M. Burton:*

Gale began on the 15th, wind SW., 4. Lowest barometer 29.37 inches at 6 a. m. on the 16th, wind W., in latitude 45° 20′ N., longitude 55° 20′ W. End of gale on the 17th, wind NNW., 5. Highest force of wind 9, W.; shifts SW.-W.

British S. S. *Randa:*

Gale began on the 15th, wind S. Lowest barometer 29.74 inches at 2 a. m. on the 15th, in latitude 58° 40′ N., longitude 2° 40′ W. End on the 17th, wind SE. Highest force of wind 9; shifts ESE.-SE.

American S. S. *City of Freeport:*

Gale began on the 17th, wind S., 7. Lowest barometer 29.89 inches at 8 a. m. on the 17th, wind SSW., 9, in latitude 50° 30′ N., longitude 23° 55′ W. End on the 17th, wind SSW. Highest force of wind 9, SSW.; shifts SW.-SSW.

On the 19th there was a LOW near Porto Rico that moved westward with all the characteristics of a tropical hurricane, which was most unusual for so late in the season. On the 23d and 24th the center was in the western Caribbean Sea, and on the latter date it began to fill in, as by the 25th it had practically disappeared. This was a moderate depression and limited in extent, as only one of the many vessels that were in its path reported winds of gale force. Storm log follows.

American S. S. *Mexican:*

Gale began on the 20th, wind NE. Lowest barometer 29.74 inches, wind NE., 7, in latitude 23° 40′ N., longitude 74° 22′ W. End on the 22d, wind NE. Highest force of wind 10, NE.; steady from NE.

On the 19th there was also a disturbance central near latitude 44° N., longitude 21° W., and northerly gales

covered a limited area in the westerly quadrants, as shown by following storm logs.

British S. S. *Arkansas:*

Gale began on the 17th, wind NW. Lowest barometer 29.70 inches at 5 p. m. on the 20th, wind N., 10, in latitude 42° 30′ N., longitude 30° 31′ W. End of the 22d, wind NNE. Highest force 10; shifts NNW.-NNE.

Danish S. S. *Virginia:*

Gale began on the 19th, wind NNE. Lowest barometer 29.63 inches at 2 p. m. on the 19th, wind NNE., 10, in latitude 44° 38′ N., longitude 33° 10′ W. End on the 19th, wind NNE. Highest force of wind 10, NNE.; steady from NNE.

This disturbance increased considerably in extent during the next three days, and on the 21st and 22d a number of vessels in the southeastern division of the ocean reported moderate to strong gales. Storm log follows:

American S. S. *Pioneer:*

Gale began on the 20th, wind NNE. Lowest barometer 29.82 inches at 11 a. m. on the 20th, wind NE., 7, in latitude 35° 15′ N., longitude 41° 48′ W. End on the 22d, wind NNE. Highest force of wind 8, NNE.; steady from NNE.

On the 22d there was a LOW of limited extent off the south coast of Newfoundland. Storm log follows.

British S. S. *Comeric:*

Gale began on the 22d, wind NW. Lowest barometer 29.86 inches at 5 a. m. on the 22d, wind NW., 9, in latitude 41° 30′ N., longitude 55° W. End on the 22d, wind N. Highest force of wind 9; shifts S.-NNW.

This disturbance remained nearly stationary during the next two days, varying in intensity, and by the 24th it was of exceptional severity, as shown by following storm logs.

Belgian S. S. *Eglantier:*

Gale began on the 23d, wind WNW. Lowest barometer 28.96 inches at 11 a. m. on the 25th, wind N., 8, in latitude 44° 38′ N., longitude 54° 40′ W. End of gale on the 26th, wind W. Highest force of wind 12; shifts, NW.-S.-SE.-N.-NW.-W.-WSW.

American S. S. *City of Freeport:*

Gale began on the 23d, wind NNW., 7. Lowest barometer 29.39 inches at 8 a. m. on the 25th, wind W., 10, in latitude 42° 35′ N., longitude 57° 10′ W. End of gale on the 26th, wind WNW. Highest force of wind 11, W.; steady from W.

From the 25th to the 26th this LOW moved rapidly in a northeastward direction, as on the latter date the center was near latitude 49° N., longitude 38° W. Storm logs follows.

British S. S. *Parthenia:*

Gale began on the 25th, wind SSE. Lowest barometer 29.30 inches at 3 p. m. on the 26th, wind SSE., 9, in latitude 53° 50′ N., longitude 28° 42′ W. End of gale on the 26th, wind SSE. Highest force of wind 10, SSE.; shifts not given.

On the 28th and 29th there was a disturbance of limited area near Hatteras, in which only one vessel reported heavy weather. Storm log follows:

American S. S. *W. G. Warden:*

Gale began on the 27th, wind S. Lowest barometer 29.76 inches at 9.50 p. m. on the 28th, wind WSW., 10, in latitude 32° N., longitude 76° 26′ W. End of gale on the 29th. Highest force of wind 11; shifts SSW.-WSW.-W. by N.

On the 30th there were two well-defined LOWS on the Atlantic; one central near Sydney, Nova Scotia, and the other near latitude 51° N., longitude 20° W. Gales were reported by vessels in widely scattered sections of the ocean, as shown by the following storm logs.

British S. S. *Navarino:*

Gale began on the 30th, wind SSW. Lowest barometer 29.50 inches at midnight on the 30th, wind SW., 8, in latitude 38° 34′ N., longitude 50° 40′ W. End of gale on December 3, wind NW. Highest force of wind 9, NW.; shifts SW.-WSW.-W.-NW.

Dutch S. S. *Eibergen:*

Gale began on the 29th, wind SE. Lowest barometer 29.20 inche at 7 a. m. on the 30th, wind S., 10, in latitude 50° 52′ N., longitude 11° W. End of gale on the 30th, SW., 4. Highest force of wind 10; shifts SE.-S.-SW.

American S. S. *H. M. Flagler:*

Gale began on the 30th, wind SW. Lowest barometer 29.80 inches on the 30th, wind SW., 7, in latitude 36° 15′ N., longitude 7° 18′ W. End of gale on December 1, wind W. Highest force of wind 9, SW.; shifts SW.-S.

NORTH PACIFIC OCEAN.

By F. G. TINGLEY.

At all three island stations in the eastern part of the North Pacific Ocean pressure during November was below normal by small amounts, as follows: Dutch Harbor, −0.19 inch; Midway Island, −0.04 inch; Honolulu, −0.02 inch. At the first-named station there were two major depressions, one reaching a minimum of 28.82 inches on the 8th, the other a minimum of 28.52 inches on the 27th. The highest pressure was 30.02 inches on the 13th. At Midway Island the lowest pressure, 29.80 inches, occurred on the 14th and the highest, 30.26 inches, on the 19th, 21st, and 22d. At Honolulu the lowest and highest pressures, with dates, were, respectively, 29.79 inches on the 16th, 30.13 inches on the 23d. Along the American coast from Cape Mendocino northward pressure was slightly below normal; to the southward of that point it was somewhat above normal.

Considering the ocean as a whole the month must be regarded as stormy, no less than 30 reporting vessels on trans-Pacific routes having experienced gales on one or more days, although during the first half of the month relative quiet prevailed east of the 165th meridian, E. longitude. West of this meridian numerous gales occurred, centering chiefly around the periods 4th–10th and 18th–23d.

On the 21st an unusually severe storm prevailed on the Oregon and British Columbian coasts. It accompanied a deep depression which formed on the southwestern side of an extensive area of high pressure that developed between Alaska and Hudson Bay on the 19th and 20th. In this storm the American tug *Sea Eagle*, bound from San Francisco to Astoria, and carrying a crew of 12 men, was lost with all hands off Peacock Spit.

From the 24th to the 27th vessels on the eastern part of the northern steamer route experienced fresh to strong southerly to westerly gales.

Representative storm logs for November are as follows:

American S. S. *Abercos*, Capt. Olaf H. Hansen, Observer C. D. Felter, Portland for Panama. Gale began on 3d in latitude 14° 18′ N., longitude 96° 07′ W., wind NE.; lowest barometer 29.89 inches at 4 a. m., same date; highest force of wind, 8, NE.; shifts, NE., E., NE., NNE.; ended on 4th.

American schooner *Melrose*, Capt. F. K. Klebingat, Hilo for Port Angeles. Gale began on 3d, wind SE.; lowest barometer, 29.56 inches at 4 a. m. of the 4th in latitude 47° 55′ N., longitude 129° 04′ W.; highest force of wind, 11, SSE.; shifts, SSE., S., W.

British S. S. *Empress of Japan*, Capt. A. V. R. Lovegrove, R. N. R., Observer G. Clarke, Vancouver for Yokohama. Gale began on 1st, wind S.; lowest barometer, 29.08 inches, at 8 p. m., same date in latitude 50° N., longitude 173° 30′ E., with wind WSW., 7; gale ended on 3d; highest wind force, 10; shifts, S., WSW.

Average weather for voyage, moderate gales from W. and NW.; high westerly seas; clear weather; occasional snow squalls.

British S. S. *Melville Dollar*, Capt. Wm. Wright, Observer W. A. Gosse, Vancouver for Yokohama. Gale began on the 10th, wind SW. by W.; lowest barometer, 28.41 inches at 8 p. m. of 9th in latitude 49° 05′ N., longitude 171° 35′ E., highest force, 10; W. by N.; shifts of wind, SW. by W. by N.; end of gale on 12th.

Dutch S. S. *Silvanus*, Capt. H. J. van Hal., Nagasaki for Vancouver. Gale began on 22d, wind ENE.; lowest barometer, 28.59 inches at 7:45 p. m. same date in latitude 50° 16′ N., longitude 176° 57′ W., wind N., 12; gale ended on 23d, wind WNW. Very high sea.

Japanese S. S. *Honolulu Maru*, Capt. K. Hirano, Observer S. Fujikawa, Yokohama for San Francisco. Gale began on 8th, wind SE.; lowest barometer 28.86 inches at 11 p. m. of 9th in latitude 42° 30′ N.,

longitude 157° E., wind WSW. 10; ended on 11th; shifts, SE., SW., WSW., W., WNW.

Second gale began on the 17th, wind S.; lowest barometer 29.11 inches at 8 a. m. of 18th in latitude 46° 06′ N., longitude 161° 20′ W., wind NE. 8; gale ended on 20th; highest force, 10; shifts, S., SE., E., NE., N., NW., W.

Japanese S. S. *Tokushima Maru*, Capt. S. Shibutami, Observer Y. Hiraiwa, Vancouver for Yokohama. Gale began at 4 a. m. on the 24th; lowest barometer, 29.27 inches, occurred at 1 p. m. in latitude 46° 09′ N., longitude 149° 30′ W.; highest force, 12, WNW.; no shifts; gale ended same day. Tremendous sea.

The *Tokushima Maru*, as well as several of the other vessels named, also experienced gales on other days.

Two typhoons occurred in the Philippine area during the month. A description of these will be found in an accompanying article by Rev. José Coronas, S. J., of the Philippine Weather Bureau.

TWO TYPHOONS OVER THE PHILIPPINES IN NOVEMBER, 1921.

By José Coronas, S. J., Chief, Meteorological Division.

[Weather Bureau, Manila, P. I., November 30, 1921.]

Two typhoons visited the Philippines during the month of November causing considerable damage, particularly in the Visayan Islands, the damage being done rather by heavy rains and floods than by the force of the winds, as the typhoon centers were not very deep.

Typhoon of November 10 and 11.—This typhoon appeared on our weather map of November 7 to the south of Guam near 10° latitude N. and 144° or 145° longitude E. With observations received from Yap, as compared with those received also from Guam, we could locate the center at 6 a. m. of the next day, November 8, between 139° and 140° longitude E. and in about 12° latitude N., the typhoon having moved WNW. since the preceding day. From the 8th it moved westward at a rate of progress of 17 to 18 miles per hour, which is considered extraordinarily high for low latitudes. Yet, when the typhoon crossed the island of Samar on the 10th, its velocity was of only about 10 miles per hour; then it increased again to 15 miles per hour on the 11th, and finally it almost stopped moving after the 12th, remaining almost stationary for about four days from the 13th until it filled up on the 17th in the neighborhood of the Paracels near 114° longitude E. and 16° latitude N.

Our weather maps of the 9th showed clearly the typhoon to the east of Samar. The center reached that island near and to the north of Borongan at 9 a. m. of the 10th, and passed practically over Calbayog at 2 p. m. of the same day, the barometric minimum observed there being 742.47 mm. (29.23 inches), gravity correction not applied. The position of the center was, therefore, at 2 p. m. of the 10th, about 12° latitude N., between 124° and 125° longitude E; its direction was then due west. Toward 10 p. m. an unexpected change in the direction of the typhoon took place: it began to move NW. or NW. by N., and hence the typhoon came to pass to the north of Manila at about 2 p. m. of the 11th. Almost immediately afterwards it inclined again westward, entering the China Sea in the evening of the 11th between Bolinao and Iba. We give herewith the position of the center on the 11th and 12th.

November 11, 6 a. m., 13° 15′ latitude N., 122° 15′ longitude E.
November 11, 2 p. m., 14° 55′ latitude N., 121° 05′ longitude E.
November 12, 6 a. m., 16° 10′ latitude N., 117° 05′ longitude E.
November 12, 2 p. m., 16° 10′ latitude N., 116° 20′ longitude E.

While the typhoon passed near Manila it was very mild, rather a depression, but it seems to have increased again in intensity in the China Sea. Many steamers had a very rough passage in coming to or going out from Manila. The Japanese steamer *New York Maru* was stranded on the 16th in the Paracels reefs 300 miles south of Hongkong. The greatest damage seems to have been done to the crops in Negros and Capiz Provinces.

Typhoon of November 24 and 25.—This typhoon was shown in our weather maps of November 21st, 2 p. m., in about 9° latitude N. and 144° or 145° longitude E. It was very similar to the typhoon of the 10th, and the first part of the track almost identical to that of the former, but with a rate of progress much more regular and constant, as it moved for the 21st to the 26th, inclusive, at a rate of about 12 miles per hour. The direction of the typhoon was WNW. on the 21st and 22d, but it moved almost due W. from the 23d to the 27th.

The approximate positions of the center for 2 p. m. of the 22d to 26th are as follows:

November 22, 10° 45′ latitude N., 139° 45′ longitude E.
November 23, 11° 20′ latitude N., 134° 45′ longitude E.
November 24, 11° 45′ latitude N., 129° 55′ longitude E.
November 25, 12° 10′ latitude N., 124° 30′ longitude E.
November 26, 12° 10′ latitude N., 120° longitude E.

On the 27th, the typhoon being about 200 miles west of Mindoro, it began to incline to the N. and then to NNE. on the 28th, and it finally filled up on the 29th, west of Balintang Channel near 20° latitude N. and 118° longitude E.

The most remarkable feature of the typhoon was a tremendous wave from the sea that flooded the municipalities of Ibajay and Macato in the Province of Capiz in the evening of November 25, when the center of the typhoon was passing about 15 or 20 miles to the north. Over 100 persons are said to have perished, and great losses to crops and properties are reported caused, not by the force of the winds, but rather by sea waves or heavy rains and floods. The first news to reach our observatory was contained in the following telegram received from our observer: "Strongest ever observed, 9 feet deep flood destroyed and washed away observatory outdoor instruments; occurred November 25 evening."

NOTES ON WEATHER IN OTHER PARTS OF THE WORLD.

British Isles.—The general rainfall for November, expressed as a percentage of the average, was: England and Wales, 75; Scotland, 55; Ireland, 106; British Isles, 75. * * *

In London, Camden Square, the mean temperature for November was 39.4° F., or 4.0° F. below the average. * * * [1]

Northern Europe.—London, November 7: Many persons were killed and enormous damage caused by heavy gales that have been sweeping northern Europe for 30 hours. * * * There has been heavy loss of shipping in British ports and telephone and telegraph communication is interrupted.—*Washington Times*, Nov. 7, 1921.

Brazil.—During November unusual frequency of high pressure was associated with cold winds from the south over the southern States. Drought affected seriously the crops in the center and south, especially cotton, rice, sugar, and maize, and reduced sensibly the estimates of the coffee crop for next year.[1]

South Africa.—Natal, November 20: Great snowstorms have occurred here, causing trains to stay at their terminals. In some places the snow lay 7 feet deep, and cattle and sheep have been frozen to death.—*Binghamton Morning Sun*, Nov. 22, 1921.

[1] *Meteorological Magazine*, December, 1921, pp. 333-334.

DETAILS OF THE WEATHER IN THE UNITED STATES.

GENERAL CONDITIONS.

By ALFRED J. HENRY, Meteorologist.

Monthly mean pressure was higher than normal along the northern boundary from North Dakota eastward; it was below normal in the North Pacific Coast States, the northern Plateau and Rocky Mountain region, and in the Ohio Valley. This pressure distribution was reflected in the mean temperature of the month and in the distribution of precipitation. The temperature along the northern boundary was lower than normal from the St. Lawrence Valley westward to Montana; positive departures obtained quite generally south of the fortieth parallel, the greatest being the Gulf States. Thus the change from almost continuous positive temperature departures having begun in the North, it may be expected that the change will progressively overspread the South. Precipitation was in excess of normal in Washington, Oregon, Idaho, and Montana in the West and in the Ohio Valley in the East; it was also in excess, although to a less extent, in the Lake region, the Middle Atlantic, and New England States. Deficient precipitation was recorded in the lower Mississippi Valley and from the Central Plains States westward and southwestward to California.

The first general storm of the winter type passed from the Pacific onto the continent on the 19th. This storm was characterized by heavy snow, sleet, and rain in North Pacific Coast States, with the usual interruption to transportation and traffic in general. The heavy snowfall in Washington and Oregon provided a much-needed supply of soil moisture. During the closing days of the month a severe snow, sleet, and rainstorm visited New England, the details of which appear elsewhere in this REVIEW, p. 612. The storm movement of the month as a whole was close to that of a normal November. Further details follow:

CYCLONES AND ANTICYCLONES.

By W. P. DAY, Observer.

Migratory high and low pressure areas showed great activity during November and many important ones were charted. Energetic storms from the North Pacific passed inland at lower latitudes than during the preceding month and the point of ingress of the Pacific HIGHS was also shifted southward. The more important HIGHS were of the Alberta type and nine pulses or invasions were noted, which is more than the average number of all types for this month. The winter Plateau HIGHS also began to make their appearance.

Tables showing the number of HIGHS and LOWS by types follow:

LOWS.	Alberta.	North Pacific.	South Pacific.	Northern Rocky Mountain.	Colorado.	Texas.	East Gulf.	South Atlantic.	Central.	Total.
November, 1921	6.0	9.0	....	2.0	1.0	2.0	1.0	2.0	2.0	25.0
Average number, 1892-1912, inclusive	4.0	2.3	0.6	0.4	1.1	1.0	0.4	0.8	1.0	11.6

HIGHS.	North Pacific.	South Pacific.	Alberta.	Plateau and Rocky Mountain Region.	Hudson Bay.	Total.
November, 1921	2.0	3.0	9.0	....	....	14.0
Average number, 1892-1912, inclusive	2.0	0.9	4.0	1.1	0.2	8.2

THE WEATHER ELEMENTS.

By P. C. DAY, Climatologist and Chief of Division.

PRESSURE AND WINDS.

In the United States November as a rule shows only a slight increase in the number of cyclones and anticyclones over those occurring in October. During November, 1921, however, both these atmospheric disturbances were greatly augmented over those for October, and more than twice the usual number for November was observed. However, few of these disturbances attained great importance, or maintained their maximum intensity over extensive paths.

The most severe storm of the month from the standpoint of property loss was that of the 27th to 29th, over the Atlantic coast districts. (See page 612 of this REVIEW.) This storm was attended by widespread precipitation over the more eastern districts of the United States, and by high winds along the middle Atlantic and southern New England coasts. Over northern districts precipitation was in the form of snow, but in portions of southern New England the temperature was sufficiently low to cause the rain to freeze as it fell, and all exposed objects were covered with ice. The accumulation of this ice was so great that overhead wire systems of all description were practically destroyed, and communication, light, and power operations were greatly interrupted. Orchards and forests, however, suffered the greatest permanent injury, the extent of which is indicated in the following extracts from the official report of the Weather Bureau observer at Hartford, Conn.:

> It is estimated that more damage was done by this storm than has been done by all the storms of the preceding 50 years. At any rate, the storm may be favorably compared with the now famous, so-called "Portland" storm in 1898. Conditions in the sections of the State mentioned were most distressing, because everywhere there were evidences of many acres of forest that were ruined, while shade and ornamental trees and shrubs, together with apple orchards, are almost totally destroyed. Stands of oak, maple, and ash have been leveled to the ground, while birches have been bent over and held down so long they can not straighten up. A tangle of broken branches covers the forest floor, and when it dries it will make a serious fire menace. Numerous light and power plants and wires were destroyed, resulting in dark towns and villages. Telephone and telegraph poles were leveled by the hundreds, and thousands of miles of wires were broken and tangled. These, however, are relatively easy to replace and repair, but the farmers and orchardists received a blow from which it is hard to recover. In many cases orchards were just beginning to bring profits and are now helpless for a period of at least 15 years. Because of the crippled condition of high-tension wires, factories were compelled to suspend operations. Public-service corporations in Hartford had practically normal service, but the service rendered by outside points was severely hit. It is impossible to estimate the money value of the various losses, though it must run into many millions in the aggregate.

The most important anticyclones of the month dominated the northern and eastern districts from the Rocky Mountains to the Atlantic coast from the 18th to 23d, during which period the lowest temperatures of the month generally occurred in the region affected.

The average pressure for the month was above normal along the northern border from the Missouri Valley eastward, in the far Southwest, and over the Canadian Provinces as far north as indicated by observations. Pressure was below normal over most central and southern districts from the Great Plains eastward and in the Rocky Mountains and far northwestern districts.

The general trend of the winds was from northerly points over the Missouri and upper Mississippi Valleys, the Great Lakes region, Atlantic coast, and east Gulf sections. They were mainly from the south in the lower

Mississippi Valley and southern Great Plains, and variable in other portions of the country.

The highest winds of the month were observed along the north Atlantic coast on the 29th, in connection with the severe cyclone passing off the southern New England coast on that date. Other high winds were confined usually to small areas.

TEMPERATURE.

The month was mainly free from unusual cold or warmth, though the maximum temperatures at a few points were the highest of record for the month, and minimum temperatures were quite low in the far West on the 18th and 19th.

The principal cold period of the month began on the 18th, when high pressure from the Canadian northwest moved into the Missouri Valley, and low temperatures prevailed for several days over central and northern districts from the Rocky Mountains eastward.

The first week of the month was decidedly warm over all districts from the Great Plains westward to the Pacific coast, and moderately warm over the Mississippi Valley, Gulf States, and along the south Atlantic coast. It was mainly cool in the Lake region, Ohio Valley, and North Atlantic States. The second week continued warm in the far West, and over considerable areas in the South, but it was decidedly cool over practically all central and northern districts from the Rocky Mountains eastward. The third week was decidedly cold over the northern border States from the upper Lakes westward to Washington and Oregon, and it was mainly cooler than normal over much of the remaining Mountain, Plateau, and Pacific coast areas. From the southern plains eastward and northeastward to the Atlantic coast this week was mostly warm.

The final week of the month was warmer than normal over practically all central and southern districts east of the Rocky Mountains, and over all districts to the westward. Along the northern border from Montana eastward this week was distinctly cooler than normal.

The principal warm periods were during the first six days over the western half of the country, the temperature on the 3d being unusually high in portions of the Plateau region. Over the eastern half of the country the period from the 17th to 19th was the warmest, on which dates maximum temperatures at a few points were as high as or higher than had previously been observed so late in the month.

The coldest weather was confined mostly to two periods. Over the districts including the middle and lower Mississippi Valley and thence eastward, the lowest temperatures occurred very generally from the 11th to 13th, while over all far western districts, the Missouri and upper Mississippi Valleys, and upper Lakes region they were observed from the 18th to 20th. The lowest temperature recorded during the month, —42°, occurred in Montana, and zero temperatures or lower were reported from all the States along the northern border, and in most of the western mountain districts.

November, 1921, brought to a close an unusually long period with average monthly temperatures above the normal over portions of the upper Mississippi Valley and Great Lakes region, where this condition has existed for many months. In other portions of this region the means were again above normal, making the fifteenth consecutive month with average temperatures above the normal, and the longest such period in the history of the Bureau.

PRECIPITATION.

At the opening of the month a well-defined storm was central over Tennessee, whence it moved east-northeastward to the vicinity of Newfoundland by the 3d, causing moderate precipitation in eastern districts, especially the lower Lake region and the central and northern portions of New York and New England. About three days later some additional precipitation occurred in the Northeast in connection with a storm that followed closely the northern border. In the Pacific Northwest considerable precipitation occurred about the 6th and again about the 13th.

Two well-marked storms moved eastward in central latitudes, one in the latter part of the first decade, and the other early in the second decade, causing light to moderate precipitation, fairly well distributed, in the regions east of the Mississippi River, with considerable snow in Michigan. Then about the 13th to 15th a large area of low pressure, that had no well-marked single center till it reached the Atlantic States, again brought rain over most sections east of the Mississippi River, with unusually heavy falls locally near the East Gulf coast.

On the morning of the 16th a vigorous storm center was over Kansas, whence it moved slowly northeastward to southern Ontario by the 19th. Decidedly heavy rains occurred in connection with this storm over Arkansas and a strip extending thence northeastward to southern Michigan and western Ohio. Cairo, Ill., recorded over 6 inches within 72 hours.

About this time and continuing well into the third decade there was widespread precipitation in far northwestern districts from northern Wyoming and central Montana westward, northern California receiving some. Wyoming, Idaho, and Montana had considerable snow, and some eastern parts of Washington and Oregon had unusual amounts for the region.

Light to moderate precipitation occurred in many northeastern districts during the early and middle parts of the final decade. On the 27th an energetic storm was central over the Ohio Valley, whence it moved eastward causing fairly well-distributed precipitation in States east of the Mississippi River, with heavy snows in northern New England and a very severe sleet and ice storm in southern New England. The Pacific States had much precipitation during the final week, especially the western counties of Washington.

The month as a whole had generally ample precipitation in regions east of the Mississippi River, the majority of States having more than the normal November amounts. There was likewise more than the usual November fall in the States from North Dakota and Wyoming westward. Precipitation was light and generally deficient in the upper Mississippi Valley, the Great Plains region, and the Southwest. Over large areas in the southern Plains there was practically no precipitation during the entire month and drought conditions were becoming serious.

SNOWFALL.

The total fall of snow during November was usually above the normal along the northern border States, particularly in northern New England, portions of the Great Lakes region, and generally over the far northwestern States. On the other hand, there was little snow from the Middle Atlantic States westward over the great central valleys, and the higher elevations of California, Arizona, Nevada, and New Mexico had amounts far less than the average November amounts.

Unusually heavy snow for November occurred on the 8th and 9th in portions of central-southern Michigan, where in the area of heaviest fall amounts up to nearly 20 inches were measured, the greatest depths ever reported in that section so early in the month. Also about the 18th to 20th unusually heavy snow occurred over portions of northern Oregon east of the Cascade Mountains and the adjacent sections of Washington and Idaho, the falls in some cases being the greatest of record for November, and nearly equaling the average annual fall.

RELATIVE HUMIDITY.

The relative amount of moisture in the atmosphere was above the normal over the greater part of the country from the Missouri and Mississippi Valleys eastward, the excess being large in portions of the Appalachian Mountains and the adjoining districts where there was much cloudy, rainy weather. From Texas and the Middle Plains westward to the Pacific the relative humidity was usually much below normal.

Severe local storms.

[The table herewith contains such data as have been received concerning severe local storms that occurred during the month. A more complete statement will appear in the Annual Report of the Chief of Bureau.]

Place.	Date.	Time.	Width of path.	Loss of life.	Value of property destroyed.	Character of storm.	Remarks.	Authority.
			Yards.					
Northern Ohio	1			3		Gale and rain	Wires and trees down, cellars flooded, and transportation services interrupted; velocity of wind 54 miles.	Plain Dealer (Cleveland, Ohio).
New Orleans, La.	13					Wind and thunder.	Some damage to roofs and buildings; electric and telephone systems out of commission in various parts of the city; 2 persons injured.	New Orleans Item (New Orleans, La.).
Reform, Ala., and vicinity	16				$5,000	Hail	Severe damage to roofs, and windows; stones weighing 1 pound fell.	The Advertiser (Montgomery, Ala.).
Arkansas (Polk, Clark and Garland Counties).	17	P. m	(1)	11		Tornadoes	Homes and barns demolished, live stock killed, wire communication interrupted and much timber destroyed; 30 persons injured; damage estimated at thousands of dollars.	United States Weather Bureau official. Commercial Appeal (Memphis, Tenn.).
Rockport, Ind. (near)	18	P. m	1,760			Cyclone	30 barns and 3 houses destroyed; damage estimated at from $100,000 to $150,000.	Evansville Courier (Evansville, Ind.).
Marshall, Tex. (few miles N. E. of).	18					Tornado	Some property damage	Official United States Weather Bureau.
Portland, Oreg	19, 20					Ice	Train service blocked, lines, poles and trees down; thousands of phones out of service.	Do.
Boston and vicinity	27, 28, 29.					do	Telephone and electric companies sustain heavy losses; shade and ornamental trees destroyed or greatly damaged; damage to orchards is estimated at well over $1,000,000.	Do.

[1] One hundred yards to one-half mile.

STORMS AND WEATHER WARNINGS.

EDWARD H. BOWIE, Supervising Forecaster.

WASHINGTON FORECAST DISTRICT.

The month was a notable one for the number of areas of high and of low pressure to cross the Washington forecast district. For the country at large, 25 separate and distinct areas of low barometer appeared during the month, while as to areas of high barometer there were 14. Many of the LOWS had their origin in and were offshoots from the subpermanent LOW of the North Pacific, and have been classed as LOWS of either the Alberta or North Pacific type, from which there developed a considerable number of secondaries. There was but one LOW of tropical origin, and it was only of moderate intensity. It had its origin over the ocean somewhere east of the Bahamas and it disappeared over the southeastern portion of the Gulf of Mexico. The HIGHS of the month did not bring unseasonable cold weather to the Washington forecast district, and the cold waves which occurred were confined to the northern border states.

A storm of considerable intensity was central the morning of the first day of the month over the central Ohio Valley, with the lowest barometer at its center 29.46 inches; moving eastward this disturbance passed off the middle Atlantic coast during the night of the 1st and thence followed a path east-northeastward toward the Grand Banks of Newfoundland. This disturbance was attended by strong northeast winds and gales on the lower Lakes and the North Atlantic coast, warnings of which were disseminated. On the 3d a disturbance made its appearance over the western Canadian provinces, advanced rapidly eastward along the northern border and reached the New England States on the 5th. On the 4th when this disturbance was crossing the Great Lakes, southwest storm warnings were displayed on Lakes Erie, Ontario, and southern Huron; the evening of the same day northwest storm warnings were displayed on the Atlantic coast at and north of Delaware Breakwater. This disturbance was attended by shifting gales in the regions where storm warnings were displayed, and it gained great intensity while moving from New England to Newfoundland. The highest velocity reported during the prevalence of this storm was 66 m. p. h. from the northwest on the 5th at New York City.

At 6 p. m. of the 7th, the following advisory information was sent to ports on the Great Lakes:

> Western disturbance central at 4 p. m. over western Kansas will move eastward and probably gain in intensity, attended by fresh easterly winds becoming strong by Tuesday morning with rain and snow. Caution advised. Later information will be sent you to-night if any change indicated.

The 8 p. m. reports showed this storm to have moved to eastern Kansas; and as the pressure gradient was considerable in its northeast quadrant, northeast storm warnings were ordered displayed on southern Lake Michigan, and on the morning of the 8th the display of northeast storm warnings was extended to Lakes Erie, Ontario, and extreme southern Huron. The storm center passed south of the Great Lakes during the 8th, attended by winds of gale force at a number of Weather Bureau stations in the area where warnings were displayed. On the morning of the 9th its center was over Kentucky, and at the same time there were indications of the development of a secondary disturbance off the North Caro-

lina coast. In expectation that the disturbance off the Carolina coast would develop very quickly and move northeastward, storm warnings were displayed at 9:30 a. m. of the 9th on the Atlantic coast at and north of Delaware Breakwater. The disturbance acted as expected, and strong winds and gales prevailed along and off the North Atlantic coast the night of the 9th and during the 10th.

Northwest storm warnings were displayed on Lakes Michigan, Superior, and Huron and southwest storm warnings on Lakes Erie and Ontario at 10 p. m. of the 18th, when a disturbance was central over the middle Mississippi Valley and moving northeastward, with every indication that it would increase greatly in intensity. This disturbance passed rapidly eastward across the Great Lakes as expected, and strong winds and gales occurred as forecast. Northwest storm warnings were also displayed at 2 p. m. of the 24th on the Atlantic coast at and north of Delaware Breakwater, when a disturbance was central over western New York. This disturbance moved rapidly eastward, and the morning of the 25th its center was over Newfoundland. The highest wind velocity attending this storm was 60 m. p. h. from the west during the night of the 24th at New York City.

The evening of the 27th, when a disturbance was central over South Carolina, in expectation that it would gain greatly in intensity and move northeastward, northeast storm warnings were displayed on the Atlantic coast at and north of Delaware Breakwater and on Lakes Erie and Ontario. This storm moved northeastward as forecast, gained great intensity, and 24 hours later its center was off the middle Atlantic coast. Thence it moved north-northeastward and at 8 p. m. of the 29th its center was off Cape Cod. The center of this disturbance passed near Sable Island during the night of the 29th, and the morning of the 30th it was in the vicinity of St. Johns, Newfoundland, where the barometer fell to 28.98 inches. This storm was the severest of the month in the Washington forecast district, causing gales and high tides on the middle Atlantic and New England coasts and attended by general and heavy rain, sleet, and snow in the New England and Middle Atlantic States. The rain, which fell with the temperature below the freezing point, caused damage estimated beyond $1,000,000 to telegraph and telephone lines in New England, and the weight of the ice damaged and destroyed many trees in the cities and forests, the value of which can not be stated. (See p. 612 this REVIEW.)

The winds along the New England coast were from the northeast and of gale force during the 28th and 29th, the highest velocities reported being 76 m. p. h. at Nantucket and 72 m. p. h. at Block Island.

In addition to the warnings for the more important storms hereinbefore enumerated, warnings were issued for disturbances of moderate intensity on other dates. No general cold waves occurred during the month. Frost warnings were issued for Southern and Central States as occasion required.—*Edward H. Bowie.*

CHICAGO FORECAST DISTRICT.

The special features of the weather in the Chicago district during the month of November were the continuation of the drought in the Southwest for the entire period and the abnormally low temperatures in the Northwest during the second and third weeks. The precipitation was in excess only in the extreme eastern portion of the district; and while the dryness in the Southwest was of greatest concern because of lack of moisture for the winter wheat, there was little precipitation in the Northwest also, except during the third week in the northern Rocky Mountain region, when heavy snow prevailed.

Conditions during the first week were generally rather mild, although frosts occurred on the morning of the 2d from the middle Mississippi Valley eastward, as well as in southern Missouri; and they were reported again on the 3d in the latter section and also in extreme southern Illinois. Because of the mildness of the previous season, frost warnings seemed necessary and they were issued for the area affected in due time.

On the morning of the 7th, a cold, high area which had moved southward from Alaska appeared in the Canadian northwest, and for two weeks following, with only slight interruptions, high pressures dominated the weather conditions over the trans-upper Mississippi region, the cold reaching its greatest intensity in Montana on the 19th, where minima were registered ranging from —8° to —26°; and on the 20th the temperature fell to zero in northern Nebraska and central Wisconsin.

Warnings were sent in advance to all interests affected, and railroads and shippers of perishable goods were especially cautioned to protect all goods subject to damage. These advices seemed especially necessary because of the unusually early occurrence of winter conditions in the Northwest. The cold, however, in its movement southeastward moderated rapidly, so that no abnormally low temperatures were registered in the southeastern portion of the forecast district. Warnings to live-stock interests were also disseminated during and previous to the period of severe cold.

Because of the threatened railroad strike and the approach of winter, the fruit interests in the States of Washington and Oregon during the month of October indicated to the Weather Bureau that advices one or two weeks in advance would be to them of the greatest importance, as they wished to hurry their shipments of fruit, especially apples, across the Northwestern States to the main distributing points, such as Chicago, St. Louis, and Kansas City. It was of greatest importance to them to make these shipments in ordinary cars at their own risk so long as the mild weather might continue, as a large amount of money would otherwise have to be spent in protection of their shipments. Under the regulations of the various railroads in the Northwest the shipper of fruit is required to declare at the time he bills his cars whether it shall be shipped at his own risk or at the carrier's risk, and in the latter case an additional charge is made where the carrier assumes the risk of freezing in transit, and in the event extreme weather is encountered the carriers oftentimes equip the cars with oil heaters, and as a result the fruit is sometimes damaged from being overheated.

Under date of November 26, 1921, the Wenatchee Northern Warehouse & Marketing Co., of Wenatchee, Wash., writes as follows:

> The information which you so kindly gave us enabled us to reach a much safer conclusion at the time of shipment whether or not it were possible to avoid the extra expense of paying for the carrier's risk, and the still greater risk of shipping during extreme weather and having the fruit damaged from overheat. You can see, naturally, that the day-to-day reports received from the Weather Bureau are not of the same advantage in this connection, but a prognostication for two weeks in advance give us a good idea of the conditions which may be encountered by cars shipped from day to day in their movement from here to the eastern markets. In fact, we wish that this service might be established definitely. We appreciate very much your interest in this matter and the manner in which your advices were given us.

The *Great Falls Tribune*, Great Falls, Mont., on November 16 includes the following statement:

> According to Great Northern officials warnings of snow and cold waves are received from the Government meteorological bureau in Chicago

from 36 to 48 hours in advance and are ordinarily authentic. Two advices regarding the approach of cold and snow have been received prior to the one received Tuesday. The last one was received last Thursday and the first about a week before.

The warning is issued in the interest of shippers and employees of the road, it was stated, and consequent upon the receipt of such warnings extraordinary precautions are taken in the shipping of perishable goods.

—*H. J. Cox.*

NEW ORLEANS FORECAST DISTRICT.

Small-craft warnings were displayed on the Texas coast on the 17th and on the east coast of Texas on the 9th and were justified.

On the morning of the 18th a trough of low pressure extended from the Lake region to Mexico, with an important center of disturbance over the Rio Grande. It was evident from the distribution of pressure that the disturbance would move rapidly and southeast storm warnings for strong southerly winds, shifting to northerly at night, were issued for the Texas coast. Winds occurred as forecast, changing to north and northwest gales at about midnight of the 18th–19th.

A warning of moderate northerly gales at Tampico and Progreso during the following 24 hours was issued on the morning of the 19th.

Warnings were issued 36 hours in advance of a moderate cold wave which overspread the extreme northwestern portion of the district on the 9th and the remainder of the northwestern portion on the 10th.

On the morning of the 18th, with a disturbance over the Rio Grande and a considerable area of high pressure to the northward, cold-wave warnings were issued for the entire district except southern Louisiana and warnings for live-stock interests were sent to interior sections. The cold wave did not reach the coast and proved to be of moderate character for the most part, although temperatures of 16° to 30° were recorded in the northwestern portion of the district.

On the 21st, after the receipt of midday special observations, cold-wave warnings were issued for Oklahoma, northwestern Arkansas, and the northern portion of west Texas and were extended the following afternoon to include the northwestern portion of east Texas as far east as Dallas. A cold wave occurred in the Texas Panhandle and northern and western Oklahoma but did not extend farther, owing to the influence of a barometric depression on the western slope of the Rocky Mountains and the eastward drift of the area of high pressure. It is interesting to note in this connection that while the influence of the western depression extended east of the Continental Divide so as to prevent the temperature at Denver, Colo., from going below freezing, a minimum temperature of 22° was recorded at Amarillo, Tex., and 28° at Oklahoma City, Okla.

Frost warnings and freezing-temperature forecasts were issued for portions of the district on the 1st, 2d, 7th, 8th, 9th, 10th, 11th, 19th, and 20th. Nearly all of these warnings were verified.—*R. A. Dyke.*

DENVER FORECAST DISTRICT.

An area of low pressure which moved from the north Pacific coast southeastward, across Montana, Wyoming, and eastern Colorado, on the 6th and 7th, was followed by a sharp fall in temperature in eastern Colorado, attended by snow flurries, during the 8th. Generally fair weather, however, without important temperature changes, prevailed during the first half of the month, with mostly high pressures over that portion of the district west of the Continental Divide, such LOWS as appeared passing to the northward and eastward.

Another LOW moved southward from British Columbia from the 14th to the 16th, with its center on the morning of the latter date over western Colorado, while the crest of a HIGH of considerable development was over Alberta. Snow was forecast for Colorado, Utah, northern New Mexico, and northeastern Arizona, with a cold wave in northern and eastern Colorado, northern New Mexico, northeastern Arizona, and southern and eastern Utah, and stockmen's warnings were distributed in northern and eastern Colorado. Snow occurred in all of the region indicated, with moderately heavy falls along the eastern slope in Colorado. Owing to a division of the storm and the slow eastward movement of the center which remained west of the Divide, the time of occurrence of the lowest temperatures was delayed 12 to 24 hours. Otherwise, the cold-wave warning was verified except in eastern Colorado. Warning of a moderate cold wave in southeastern New Mexico was issued on the 18th and was fully verified by the morning of the 19th.

From the 18th to the 23d, low pressures prevailed from the north Pacific coast southeastward to eastern Colorado, without any attendant precipitation in this district except in northwestern Colorado on the 19th and 23d and occasionally in northern Utah. A cold-wave warning issued on the evening of the 20th for north-central Colorado failed of verification because that portion of the extensive LOW, already referred to, which was over southern Wyoming remained almost stationary. A moderate cold-wave forecast on the morning of the 23d for southwestern Utah was fully verified during the following 24 hours.

A disturbance of moderate intensity which began to appear in Arizona on the 24th extended northeastward to South Dakota on the 25th, causing rain or snow in northern Arizona, southern Utah, and western Colorado. Occasional light precipitation in central Arizona on the 28th and 29th and in southern New Mexico on the 29th and 30th attended a moderate disturbance which was first noted over Nevada on the morning of the 27th and which had moved to eastern New Mexico by the morning of the 30th.

A cold wave for which warnings had not been issued occurred at Durango on the 18th.

Forecasts of freezing temperature were issued for eastern Colorado on the 1st and 2d which were verified except in the east-central portion of the State on the 3d. The season was so far advanced that warnings of ordinary freezing weather were not considered necessary after the last-named date, except in southern and western Arizona.

Frost warnings were issued for western and southern Arizona on the 16th, 18th, 19th, 20th, and 21st, and for southern Arizona on the 22d, the warning of the 18th containing a forecast of freezing temperature in the northwestern and near freezing in the south-central and southeastern portions of that State. These were verified by the occurrence of frosts or temperatures at which frosts might be expected except in southern Arizona on the 17th and extreme southwestern Arizona on the 21st.

The first damaging frost occurred in the southern portion of Arizona on the 19th, when the temperature fell to 30° at Phoenix and to 36° at Yuma. Light frosts, without warnings, occurred at Phoenix on the 8th and 11th, when the minimum temperature was 43° and 41°,

respectively, and a heavy frost was reported on the 18th, when a minimum temperature of 36° was reached at the same station.—*J. M. Sherier.*

SAN FRANCISCO FORECAST DISTRICT.

Two very distinct pressure types were alternately in control of weather conditions in the Pacific States during November—high pressure over the western part of the United States was dominant during the forepart of the month and low pressure during the latter part.

Except for a disturbance for which southwest storm warnings were displayed in Oregon and Washington on the 4th, the weather was settled and rainless in most sections, with a hot spell in California until the 14th. On that date a disturbance entered the north coast and moved southeastward over the plateau. Its passage was followed by a series of heavy frosts in California extending from the 16th to the 20th. All of the severer ones were covered by warnings. The freezing temperatures did not reach southern California until the 18th, a day later than was expected, due to the sluggish eastward movement of the LOW then centered in Arizona, and one unverified warning of light frost was issued as a result.

Coincident with the passage of this storm was the southward advance of the Alaska HIGH. Colder weather in connection with this movement was foreseen in the northwest, and special warning was sent on the 17th to fruit storage and shipping interests in northeastern Washington of an expected period, with temperatures considerably below freezing. This warning was fully justified by the event.

From the 19th until the close of the month the weather in this district was dominated by the North Pacific low-pressure system which shifted southeastward so as to impinge on the Pacific coast. So plain was the evidence of a change in weather type that advice was issued several days in advance to forestry parties in the high Sierra of impending snowfall that would impede their withdrawal from the mountains.

Southeast storm warnings were put up at Oregon and Washington seaports on the 19th and displayed thereafter with but few interruptions until the 30th. Occasionally they were altered in direction, and on two occasions they were extended to include the California coast as far south as Mendocino. There was one marine casualty of note during this time. The tug *Sea Eagle*, which left San Francisco for Coos Bay on the 16th, never arrived at that port. All that is known regarding her loss is deduced from some of her wreckage washed ashore on the Oregon coast a few miles south of the Columbia River on the 24th.

Forecast problems this month clearly illustrated the value of timely vessel weather reports. Several failures to accurately predict the weather in this district may be attributed to the nonreceipt of such reports. Two ill-advised frost warnings for northern California, those of November 23 and 28, may be explained thus: In the case of the first one it was seen a few hours after the forecast had been made that conditions presaged rain rather than frost, the S. S. *Eldridge* reporting from a position off the southern Oregon coast facts which contained the information requisite for an intelligent prediction. On the other hand, a number of forecasts for California, Oregon, and Washington were influenced in the right direction through the aid derived from a knowledge of conditions over the adjacent ocean.—*Thomas R. Reed.*

MEAN LAKE LEVELS DURING NOVEMBER, 1921.

By UNITED STATES LAKE SURVEY.

[Detroit, Mich., December 3, 1921.]

The following data are reported in the "Notice to Mariners" of the above date:

Data.	Lakes.[1]			
	Superior.	Michigan and Huron.	Erie.	Ontario.
Mean level during November, 1921:	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Above mean sea level at New York	602.20	579.64	571.80	244.85
Above or below—				
Mean stage of October, 1921	−0.33	−0.22	+0.01	−0.26
Mean stage of November, 1920	−0.28	−0.66	−0.15	−0.38
Average stage for November, last 10 years	−0.39	−0.67	−0.12	−0.80
Highest recorded November stage	−1.31	−3.28	−1.87	−2.97
Lowest recorded November stage	+0.70	+0.46	+1.10	+1.44
Average relation of the November level to—				
October level		−0.20	−0.20	−0.20
December level		+0.10	+0.10	+0.10

[1] Lake St. Clair's level: In November, 574.55 feet.

RIVERS AND FLOODS.

By H. C. FRANKENFIELD.

Atlantic drainage.—The heavy rains from November 26 to 29 caused decided rise in the rivers of New York and Pennsylvania, although flood stages were not reached in the Hudson River system. Flood stages were also approached or slightly exceeded in the North Branch of the Susquehanna and its tributaries, but the total damage reported was only about $8,000.

Over the South Atlantic drainage area there were no floods except a very moderate one in the Santee River during the early days of the month, due to heavy rains on October 30 and 31. There was no damage. A flood warning on November 28 for the Santee River was not quite justified, probably owing to the dry period that preceded the rainfall.

Mississippi drainage, Ohio branch.—Moderate rains that fell on a previously dry soil from November 24 to 29, inclusive, caused a rapid rise in the upper Ohio River and its tributaries, and flood stages prevailed along the river almost as far as Parkersburg, and also in the vicinity of Point Pleasant, W. Va. Warnings were first issued on November 28, and the crest stages reached did not differ materially from the forecast stages.

The crest stage at Pittsburgh was 25.4 feet, 3.2 feet above the flood stage, at 2 p. m. November 29; at Marietta, Ohio, 34 feet, or 1 foot above the flood stage, at 10 p. m. November 30; at Parkersburg, W. Va., 35.9 feet, 0.1 foot below the flood stage, at 1 a. m. December 1; and 43.5 feet, or 3.5 feet above the flood stage, from 2 p. m. November 30 to 6 a. m. December 1. The flood stage at Point Pleasant was due to the run-off from the Great Kanawha River and had little or no effect on the Ohio River below.

The Monongahela, Kiskiminetas, lower Allegheny, Little Kanawha, and lower Licking Rivers also experienced flood stages.

The total of losses and damage reported in the Pittsburgh district amounted to about $25,000 and in the Parkersburg district to about $10,000.

Heavy rains from November 16 to 18, inclusive, averaging from 3 to more than 6 inches over portions of Indiana, Kentucky, and Illinois, caused unusually rapid rise in the Wabash and White Rivers. Warnings for the

White River were first issued on November 18 and frequently thereafter.

Although flood stages were general over the lower watersheds, the only losses of consequence were of corn in the fields, the value of which was probably about $20,000. The warnings were of great value to those having portable property in the lowlands.

Frequent warnings were also issued, beginning with November 18, for the Wabash River. The crest stage at Lafayette, Ind., was 20 feet, or 9 feet above flood stage, on November 21; at Terre Haute, Ind., 18.9 feet, or 2.9 feet above flood stage, on November 24 and 25; at Vincennes, Ind., 16.9 feet, or 2.9 feet above flood stage, on November 28; and at Mount Carmel, Ill., 21.8 feet, 6.8 feet above flood stage, on November 29.

The losses and damage reported amounted to about $165,000, mostly in unhusked corn, while the estimated property saved through the Weather Bureau warnings s about $150,000.

While flood stages were not reached in the Green and Big Barren Rivers, and in the Evansville district of the Ohio River, yet it was thought advisable by the official in charge of the district to issue flood warnings on November 19 in order that farmers might be enabled to save the larger quantities of corn in the lower bottoms, and this was done.

Later in the month another protracted rain period necessitated additional warnings for the Ohio and Green Rivers, beginning with November 27, and ending with December 5. The rise from the upper Ohio River reached the Evansville district about the end of the month, and materially increased the Ohio River stages. The crest at Evansville was 39.58 feet, at 1 p. m. December 6; forecast stage near 40 feet; at Henderson, Ky., 37.5 feet, at 7 a. m. December 7; forecast stage near 38 feet, and at Mount Vernon, Ind., 38.8 feet, at 4 p. m. December 7; forecast stage, near 39 feet. The Green River was also in flood, and did not fall below the flood stage at Lock No. 2, Rumsey, Ky., until 2 p. m., December 8.

While much inconvenience resulted, there were no losses of consequence, as the corn had been gathered upon advices issued during the previous rise.

Mississippi system.—The heavy rains of November 18 and 19 also caused a rather rapid rise in the Illinois River, the Missouri River below Jefferson City, Mo., the Meramec River, and the Mississippi River between Grafton, Ill., and Cape Girardeau, Mo. However, flood stages were not reached, except in the Illinois and Meramec Rivers.

Warnings for the Illinois River were first issued on November 20. The Illinois River floods are very slow, and the river was still in flood at the close of the month, with another rise in prospect. The warnings were sufficiently timely to prevent inconvenience or loss.

Warnings for the Meramec River were issued on November 19, and were fully verified. There was some inconvenience but no losses of consequence.

Lake Erie drainage.—There was a moderate flood in the Maumee River at Fort Wayne, Ind., on November 21, due to the general rains from November 16 to 19, inclusive, combined with a moist soil resulting from melting snow previous to November 15. From November 16 to November 21, the river at Fort Wayne rose from 4.5 to 16.1 feet (flood stage 15 feet), and warnings were issued on November 19, when the river stood at 12.7 feet. Lowlands were inundated, but there was no other damage.

There were no other floods except in the Willamette system. These latter were caused by a rainfall of from 4 to 7.5 inches between November 19 and 21, and the crest stages were from 1 to 9.5 feet above the flood stages, the greatest excess occurring in the Santiam River at Jefferson, Oreg. On November 30 flood stages were again reached in the Santiam River and in the Willamette at Eugene, Oreg. Warnings were issued on November 21. Considerable damage was done to bridges, buildings, and fences near Jefferson, Oreg., but no serious damage at other points. The warnings were sufficiently in advance to admit of the removal of portable property to places of safety.

On November 1, 1921, the supervision of the river district of the Red River of the North was transferred from the Weather Bureau office at Devils Lake, N. Dak., to the office at Moorhead, Minn., its original location.

Flood stages during November, 1921.

River and station.	Flood stage.	Above flood stages—dates. From—	Above flood stages—dates. To—	Crest. Stage.	Crest. Date.
ATLANTIC DRAINAGE.					
Mohawk:	*Feet.*			*Feet.*	
Tribeshill, N. Y.	16	28	29	18.8	28
Susquehanna:					
Oneonta, N. Y.	12	28	30	14.0	29
Bainbridge, N. Y.	11	28	28	14.9	28
Binghamton, N. Y.	14	29	29	14.3	29
Wilkes-Barre, Pa.	20	29	(*)	22.4	29
Unadilla:					
New Berlin, N. Y.	8	28	28	8.0	28
Santee:					
Rimini, S. C.	12	3	5	12.4	4
GREAT LAKES DRAINAGE.					
Maumee:					
Fort Wayne, Ind.	15	20	22	16.1	21
MISSISSIPPI DRAINAGE.					
Ohio:					
Pittsburgh, Pa.	22	29	29	25.4	29
Davis Island Dam, Pa.	25	29	29	25.3	29
Beaver Dam, Pa.	30	29	(*)	34.2	29
Marietta, Ohio	33	30	(*)	34.0	30
Point Pleasant, W. Va.	40	30	(*)	43.5	30
Dam No. 29, Ky.	50	30	30	50.3	30
Evansville, Ind.	35	30	(*)	35.1	30
Allegheny:					
Herrs Island Dam, Pa.	22	29	(*)	25.7	29
Conemaugh-Kiskiminitas:					
Saltsburg, Pa.	8	29	29	14.7	29
Stony Creek:					
Johnstown, Pa.	10	28	29	12.3	28
Monongahela:					
Lock No. 15, W. Va.	22	28	29	23.8	28-29
Lock No. 7, Pa.	30	29	29	32.0	29
Lock No. 4, Pa.	31	29	29	34.9	29
Little Kanawah:					
Glenville, W. Va.	23	29	29	24.1	29
Creston, W. Va.	20	29	29	20.3	29
Licking:					
Falmouth, Ky.	28	17	18	29.8	17-18
Green:					
Lock No. 6, Ky.	30	30	(*)	31.0	30
Lock No. 4, Ky.	33	29	(*)	38.1	30
Wabash:					
Terre Haute, Ind.	16	20	28	18.9	25
Mount Carmel, Ill.	15	21	(*)	21.8	29
White:					
Decker, Ind.	18	24	(*)	21.5	28
Illinois:					
Peru, Ill.	14	21	(*)	15.5	24
Henry, Ill.	7	22	(*)	9.1	27, 29
Peoria, Ill.	16	27	28	16.1	28
Beardstown, Ill.	12	27	(*)	12.8	30
Meramec:					
Pacific, Mo.	11	21	22	13.4	21
Valley Park, Mo.	14	21	22	16.2	21
Bourbeuse:					
Union, Mo.	10	21	21	10.9	21
Petit Jean:					
Danville, Ark.	20	19	22	23.9	20
PACIFIC DRAINAGE.					
Willamette:					
Eugene, Oreg.	10	21	22	14.0	22
Albany, Oreg.	20	23	24	23.2	23
Salem, Oreg.	20	22	24	24.5	22
Oregon City, Oreg.	12	22	26	15.1	23
Portland, Oreg.	15	23	25	17.0	23
McKenzie:					
Hendricks Bridge, Oreg.	14	21	21	15.0	21
Santiam:					
Jefferson, Oreg.	10	21	23	19.5	21
	10	30	(*)	13.0	30
Yamhill:					
McMinnville, Oreg.	35	22	23	39.4	22
Clackamas:					
South Fork, Oreg.	12	19	20	14.8	19

* Continued into December.

EFFECT OF WEATHER ON CROPS AND FARMING OPERATIONS, NOVEMBER, 1921.

By J. WARREN SMITH, Meteorologist.

The first week in November was abnormally warm in all sections of the country except in the Eastern States, and very little precipitation occurred in any section. The second week was unseasonably cold from the upper Mississippi Valley eastward, and thereafter temperatures were above normal in most districts. The weather was favorable for outdoor work, except for considerable interruption in northern districts during the middle portion of the month by cold and snow, and the soil was too dry for plowing and seeding from the lower Great Plains southward. Cotton picking and ginning continued to make satisfactory progress under favorable weather conditions.

Winter grains were favorably affected by the weather from the Mississippi Valley eastward and they continued mostly in satisfactory condition in that area. Soil moisture was greatly improved after the first week in the month from Tennessee southward and in the Southeast, which facilitated seeding winter cereals and germination of grain. The drought was intensified, however, by lack of rainfall from the lower Great Plains southward and southwestward, and there was a steady deterioration of winter grains in that section. Unusually heavy snow fell in the eastern portions of Washington and Oregon during the week ending November 22, which was very beneficial to wheat in that area, while the droughty conditions in California were somewhat relieved by additional soil moisture the latter part of the month.

There was sufficient moisture during most of the month for truck in the Southern States from the Mississippi River eastward, and the warm weather favored growth, but deficient moisture was very unfavorable for garden and truck crops in Louisiana and Texas. The cutting and grinding of cane made rapid progress in the lower Mississippi Valley under favorable weather conditions. Ranges were dry and poor throughout the month in the Southwest, including the lower Great Plains, with a scarcity of water supply for stock in many localities. The heavy snowfall and unusually cold weather were trying on stock also, during the middle portion of the month from eastern Washington eastward to Minnesota, with considerable suffering and shrinkage in some localities. Stock continued in satisfactory condition in other districts.

The weather was generally favorable for fruits and fruit trees, except that a severe glaze storm near the close did considerable damage to trees in New England, and cooler weather would have favored better development of citrus fruits in Florida.

CLIMATOLOGICAL TABLES.*

CONDENSED CLIMATOLOGICAL SUMMARY.

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course, the number of such records is smaller than the total number of stations.

Condensed climatological summary of temperature and precipitation by sections, November, 1921.

Section.	Temperature.								Precipitation.					
	Section average.	Departure from the normal.	Monthly extremes.						Section average.	Departure from the normal.	Greatest monthly.		Least monthly.	
			Station.	Highest.	Date.	Station.	Lowest.	Date.			Station.	Amount.	Station.	Amount.
	°F.	°F.		°F.			°F.		In.	In.		In.		In.
Alabama	58.3	+4.0	Clanton	87	18	Maple Grove	25	11†	3.63	+0.65	Mentone	7.06	Healing Springs	0.97
Arizona	52.7	+1.5	Avondale	98	3	Alpine	−3	19	0.36	−0.53	Maricopa	7.55	12 stations	0.00
Arkansas	54.9	+3.4	Mount Ida	88	17	2 stations	17	12	5.53	+1.96	Searcy	13.77	Springbank	1.10
California	54.3	+1.4	San Bernardino	98	3	Portola	−3	18	1.44	−1.37	Crescent City	15.09	9 stations	0.00
Colorado	37.8	+3.1	2 stations	83	3†	Lay	−17	18	0.59	−0.18	Silver Lake	2.55	4 stations	0.00
Florida	68.0	+3.2	Orlando	92	15	De Funiak Springs	29	13	2.64	+0.27	Jupiter	6.41	Homestead	0.00
Georgia	58.1	+3.4	Americus	87	18	Blue Ridge	20	13	3.87	+1.22	Ramhurst	8.48	Savannah	1.20
Hawaii	71.1	−0.4	Mahukona	92	17	Volcano Observatory	49	2†	10.49	+2.71	Honomu	59.32	2 stations	0.00
Idaho	38.2	+2.7	Bliss	77	3	Sandpoint	−10	19	2.92	+0.91	Musselshell	9.55	Murphy	0.15
Illinois	42.6	+0.7	2 stations	77	6	Freeport	7	12	3.74	+1.34	Cairo	11.18	Warsaw	0.96
Indiana	44.2	+2.1	Marion	75	18	Salamonia	11	12	5.98	+2.92	Greenfield	11.35	Notre Dame	1.91
Iowa	33.6	−1.4	4 stations	70	4†	Sanborn	−5	20	0.58	−0.93	Clinton	1.61	7 stations	T.
Kansas	43.8	−0.5	2 stations	89	4†	4 stations	3	23	0.07	−1.11	Columbus	1.23	26 stations	0.00
Kentucky	49.7	+3.6	5 stations	79	6†	Greenville	20	12	7.96	+4.61	Blandville	13.07	Pikeville	3.78
Louisiana	63.9	+5.4	Houma	91	15	Calhoun	26	10	2.22	−1.09	Donaldsonville	5.52	2 stations	0.40
Maryland-Delaware	46.9	+2.0	2 stations	82	18	Grantsville, Md	15	13	4.30	+1.76	Bell, Md	6.59	Chewsville, Md	2.57
Michigan	33.7	−2.2	Omer	66	1	Humboldt	−16	20	2.47	−0.02	Howell	5.38	Iron River	0.30
Minnesota	23.2	−6.0	Milan	67	3†	Itasca State Park	−29	20	0.77	−0.21	Maple Plain	2.21	Fosston	0.06
Mississippi	60.2	+5.4	2 stations	89	14†	Moorhead	25	29	2.41	−1.03	Hernando	6.54	Monticello	0.22
Missouri	45.6	+1.2	Dean	84	5	Houston	10	12	2.82	+0.40	New Madrid	11.73	Kidder	0.00
Montana	30.0	−1.8	Chinook	82	5	Kinread	−42	19	1.76	+0.72	Haugan	7.05	2 stations	0.28
Nebraska	36.7	+0.2	Gothenburg	84	6	Gordon	−10	18	0.32	−0.41	Nenzel	1.05	2 stations	0.00
Nevada	44.0	+4.1	Las Vegas	86	2	Rye Patch	−7	18	0.33	−0.34	Vya	1.65	8 stations	0.00
New England	35.4	−1.3	2 stations	75	19	Presque Isle, Me	−10	27	5.86	+2.29	Westboro, Mass	9.64	Waterbury, Conn	2.14
New Jersey	44.3	+1.2	3 stations	79	18	2 stations	18	6†	4.26	+1.17	Atlantic City	6.69	Long Branch	2.79
New Mexico	45.5	+2.3	Elephant Butte	90	2	2 stations	2	19	0.13	−0.46	Tyrone	1.27	40 stations	0.00
New York	37.4	−0.1	Townsend	78	19	Indian Lake	−3	8	5.23	+2.44	Romulus	8.55	Ogdensburg	1.57
North Carolina	53.6	+4.4	Greenville	88	18	3 stations	18	13	3.18	+0.79	Lumberton	9.08	Tryon	1.30
North Dakota	20.9	−5.7	Bowman	69	3	Howard	−30	19	0.68	+0.10	Donnybrook	2.06	Lisbon	0.05
Ohio	42.9	+1.6	2 stations	80	18	Green Hill	13	13	5.66	+2.99	Clarington	9.91	North Bass Island	2.50
Oklahoma	52.3	+1.7	Beaver	89	6	2 stations	8	23	1.01	−1.33	Poteau	9.24	15 stations	0.00
Oregon	43.6	+1.6	Prairie City	78	3	Blitzen	2	10†	7.02	+2.72	Government Camp	23.79	Blitzen	0.23
Pennsylvania	42.3	+1.3	5 stations	80	18	West Bingham	3	13	5.75	+3.20	Clearfield	9.14	Harrisburg	2.30
South Carolina	56.9	+3.0	2 stations	86	18†	2 stations	24	13	3.11	+0.81	Clemson College	5.61	Pinopolis	1.11
South Dakota	28.7	−4.1	Spearfish	80	30	2 stations	−24	19	0.59	−0.10	Lemmon	1.50	Fairfax	0.12
Tennessee	52.0	+3.5	2 stations	81	17†	2 stations	21	11†	5.88	+2.44	Sewanee	8.50	Johnson City	3.85
Texas	62.0	+5.0	Eagle Pass	100	14	Clint	9	19†	0.95	−1.44	Denison	7.93	21 stations	0.00
Utah	41.0	+3.6	Springdale	80	3	Manila	−5	18	0.51	−0.43	Silver Lake	1.94	2 stations	0.00
Virginia	50.0	+3.6	5 stations	82	18†	Burkes Garden	15	11†	3.03	+0.60	Mount Weather	5.08	Callaville	1.25
Washington	39.7	−0.3	2 stations	74	6	Republic	−14	19	6.51	+0.93	Silverton	26.04	Wahluke	0.92
West Virginia	46.1	+3.5	Moorefield	85	18	Pickens	11	13	5.99	+3.13	Charleston	8.81	Romney	2.52
Wisconsin	29.3	−3.9	Stevens Point	68	1	3 stations	−24	20	1.29	−0.44	Racine	2.81	Iron River	0.53
Wyoming	33.2	+0.8	Fort Laramie	81	5	South Pass City	−18	18	0.91	+0.29	Moran	3.60	Green River	0.07

* For description of tables and charts, see REVIEW, January, 1921, p. 41.

† Other dates also.

TABLE 1.—*Climatological data for Weather Bureau stations, November, 1921.*

Districts and stations.	Elevation of instruments: Barometer above sea level.	Elevation of instruments: Thermometer above ground.	Elevation of instruments: Anemometer above ground.	Pressure: Station, reduced to mean of 24 hours.	Pressure: Sea level, reduced to mean of 24 hours.	Pressure: Departure from normal.	Temperature of the air: Mean max. + mean min. ÷ 2.	Temperature of the air: Departure from normal.	Maximum.	Date.	Mean maximum.	Minimum.	Date.	Mean minimum.	Greatest daily range.	Mean wet thermometer.	Mean temperature of the dew-point.	Mean relative humidity.	Precipitation: Total.	Precipitation: Departure from normal.	Days with 0.01 inch or more.	Wind: Total movement.	Wind: Prevailing direction.	Maximum velocity: Miles per hour.	Maximum velocity: Direction.	Maximum velocity: Date.	Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness, tenths.	Total snowfall.	Snow, sleet and ice on ground at end of month.
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F		°F	°F.		°F	°F.	°F.	°F.	%	In.	In.		Miles								0-10	In.	In.
New England.							38.7	− 0.4										82	5.35	+ 1.8										7.9		
Eastport	76	67	85	29.95	30.04	+ .03	34.0	− 2.8	58	19	39	14	26	29	22	32	29	84	5.11	+ 1.0	20	10,730	nw.	41	ne.	28	2	4	24	8.6	16.2	8.0
Greenville, Me.	1,070	6		28.86	30.07		27.2		52	20	33	7	23	22	21				5.69		16						3	2	25		44.7	
Portland, Me.	103	82	117	29.96	30.09	+ .05	35.3	− 2.3	57	19	40	20	27	30	22	32	28	79	6.85	+ 3.0	19	7,162	n.	42	nw.	5	4	5	21	7.9	24.3	18.0
Concord	288	70	79	29.74	30.06	.00	35.4	− 1.4	69	19	41	20	24	30	36				4.34	+ 1.0	19	3,846	n.	34	nw.	5	5	3	22	8.3	20.1	9.8
Burlington	404	11	48	29.60	30.06	+ .01	32.7	− 1.0	70	19	38	15	8	27	23				3.69	+ 1.1	22	7,852	s.	48	nw.	5	1	4	25	8.8	23.0	4.6
Northfield	876	12	60	29.10	30.08	+ .03	31.2	− 0.8	66	19	38	8	8	25	28	29	26	84	4.66	+ 2.1	19	4,782	s.	28	se.	19	1	4	25	8.9	35.6	11.9
Boston	125	115	188	29.92	30.06	+ .01	41.6	+ 0.4	72	19	48	25	8	35	25	38	35	80	6.19	+ 2.1	18	7,622	w.	43	w.	5	7	5	18	7.3	1.6	0.0
Nantucket	12	14	90	30.01	30.02	− .03	46.0	+ 0.8	64	19	52	33	8	41	23	43	41	85	5.25	+ 2.0	19	13,119	w.	79	ne.	29	6	2	22	7.8	T.	0.0
Block Island	26	11	46	30.01	30.04	− .02	45.2	− 0.1	64	19	50	29	8	40	20	42	39	82	6.50	+ 2.6	17	16,167	ne.	71	ne.	29	6	6	18	6.9	T.	0.0
Providence	160	215	251	29.88	30.05	− .02	41.0	+ 0.6	70	19	48	25	24	34	24	37	34	80	6.35	+ 2.4	19	9,004	nw.	67	nw.	5	9	4	17	6.8	0.5	0.0
Hartford	159	122	140	29.89	30.07	− .01	40.9	+ 1.4	70	19	47	25	24	35	29	37	34	82	5.28	+ 1.5	20	5,252	n.	39	n.	5	3	6	21	8.2	T.	0.0
New Haven	106	74	153	29.94	30.06	− .01	42.3	+ 1.0	67	19	49	27	24	36	27	38	35	80	4.65	+ 1.1	15	6,655	ne.	36	ne.	28	5	8	17	7.3	T.	0.0
Middle Atlantic States.							46.6	+ 2.4										79	3.86	+ 1.0										6.8		
Albany	97	102	115	29.96	30.07	− .01	39.0	+ 0.6	71	19	44	22	24	34	22	36	33	82	5.50	+ 2.7	17	5,360	nw.	41	s.	19	6	3	21	7.9	2.5	T.
Binghamton	871	10	84	29.09	30.04	− .05	39.7	+ 2.1	72	19	45	24	13	34	27				5.89	+ 3.6	17	4,538	w.	28	s.	19	1	4	25	8.7	0.9	0.0
New York	314	414	454	29.71	30.06	− .03	45.0	+ 1.0	71	19	51	30	13	39	24	41	37	77	3.48	0.0	15	12,615	nw.	62	nw.	5	3	10	17	7.6	T.	0.0
Harrisburg	374	94	104	29.67	30.08	− .03	43.8	+ 2.1	76	18	50	29	13	37	30	40	35	76	3.20	+ 0.8	15	5,069	ne.	31	s.	19	3	10	17	7.6	T.	0.0
Philadelphia	117	123	190	29.94	30.08	− .02	46.8	+ 1.9	75	19	53	32	13	41	22	43	40	80	3.69	+ 0.6	16	7,399	nw.	32	nw.	5	7	7	16	6.9	T.	0.0
Reading	325	81	98	29.72	30.07		43.7		78	18	50	28	13	38	28	41	38	81	5.87	+ 2.8	17	2,575	nw.	20	nw.		3	9	18	7.4	2.0	0.0
Scranton	805	111	119	29.18	30.06	− .03	41.2	+ 2.1	74	18	47	25	13	35	19	38	36	82	5.03	+ 2.7	18	5,366	sw.	30	w.	5	1	10	19	8.0	1.6	0.0
Atlantic City	52	37	48	30.00	30.06	− .04	48.2	+ 2.7	66	7	54	29	13	42	22	45	43	84	6.69	+ 3.5	13	5,768	nw.	28	ne.	28	10	6	14	6.2	0.0	0.0
Cape May	18	13	49	30.07	30.09	− .01	49.2	+ 1.8	65	7	55	34	13	43	23	46	43	82	3.22	0.0	15	6,902	nw.	36	nw.	5	8	8	14	6.3	0.0	0.0
Sandy Hook	22	10	55	30.03	30.05		45.6		69	18	51	32	13	41	20	42	39	80	2.95		15	12,420	w.	50	nw.	25	6	10	14	6.5	T.	0.0
Trenton	190	159	183	29.85	30.06		44.6		76	18	52	27	13	38	28	41	38	81	2.83	− 0.6	15	8,619	w.	44	w.	10	4	9	17	7.1	T.	0.0
Baltimore	123	100	113	29.33	30.07	− .04	48.1	+ 2.3	75	19	55	31	13	42	26	43	39	75	4.37	+ 1.4	10	4,032	nw.	19	sw.	1	6	11	13	6.6	T.	0.0
Washington	112	62	85	29.94	30.07	− .05	47.5	+ 2.5	80	18	55	29	16	40	27	43	38	73	4.15	+ 1.4	14	4,629	n.	33	nw.	12	5	9	16	7.2	T.	0.0
Lynchburg	681	153	188	29.32	30.08	− .05	50.6	+ 4.5	75	18	60	26	13	41	40	45	40	74	1.65	− 1.1	8	5,006	w.	34	nw.	12	7	13	10	5.7	0.0	0.0
Norfolk	91	170	205	29.98	30.08	− .03	55.8	+ 4.6	77	19	63	36	13	48	24	50	47	81	1.70	− 1.0	8	8,495	ne.	37	nw.	29	13	7	10	5.1	0.0	0.0
Richmond	144	11	52	29.92	30.08	− .04	51.6	+ 2.8	79	19	62	26	13	42	33	46	43	81	2.97	+ 0.6	9	5,427	ne.	28	nw.	12	10	10	10	5.4	0.0	0.0
Wytheville	2,304	49	56	27.68	30.10	− .03	46.3	+ 3.3	72	17	56	22	13	37	33	41	37	78	1.49	− 1.6	12	5,165	w.	34	w.	28	10	5	15	6.0	T.	0.0
South Atlantic States.							58.6	+ 4.5										80	2.75	− 0.4										5.2		
Asheville	2,255	70	84	27.73	30.11	− .03	49.8	+ 4.7	75	17	59	25	13	40	37	43	39	76	2.31	− 1.0	11	6,659	nw.	39	nw.	28	10	6	14	5.7	T.	0.0
Charlotte	779	55	62	29.24	30.09	− .04	54.0	+ 3.6	75	19	63	29	13	45	30	48	44	77	4.02	+ 1.2	11	3,304	ne.	23	nw.	12	10	4	16	6.0	0.0	0.0
Hatteras	11	12	50	30.05	30.06	− .07	60.8	+ 4.1	76	18	67	44	13	55	19	57	55	84	4.73	+ 0.1	10	9,412	w.	40	nw.	29	14	6	10	4.8	0.0	0.0
Manteo	12	5	42																													
Raleigh	376	103	110	29.68	30.09	− .04	54.6	+ 4.4	78	19	64	29	13	45	29	49	45	79	2.13	− 0.2	9	5,204	sw.	34	w.	28	10	11	9	5.3	0.0	0.0
Wilmington	78	81	91	30.01	30.10	− .02	59.6	+ 5.5	79	17	69	32	13	50	29	54	51	82	2.22	− 0.2	6	4,606	w.	24	w.	28	14	10	6	4.0	0.0	0.0
Charleston	48	11	92	30.04	30.10	− .02	62.0	+ 3.9	80	17	70	40	13	54	25	56	54	83	1.82	− 1.0	6	6,244	w.	35	w.	28	13	9	8	4.5	0.0	0.0
Columbia, S. C.	351	41	57	29.72	30.11	− .01	58.4	+ 4.6	81	18	68	35	13	48	42	51	46	76	2.47	+ 0.2	7	4,067	w.	33	w.	28	11	8	11	5.5	0.0	0.0
Due West	711	10	55	29.34	30.12		54.4		75	7	63	33	13	45	31				3.03		11	5,317	sw.	35	w.	28	12	4	14	5.2	0.0	0.0
Greeneville, S. C.	1,039	113	122	28.97	30.08		54.0		74	7	62	31	13	46	29	48	44	76	3.38		10	5,303	ne.	36	w.	28	13	3	14	5.9	0.0	0.0
Augusta	180	62	77	29.89	30.09	− .04	58.4	+ 4.5	80	18	68	33	13	49	36	52	49	81	4.34	− 1.9	10	3,358	nw.	26	w.	28	9	10	11	5.7	0.0	0.0
Savannah	65	150	194	30.03	30.10	− .02	63.0	+ 5.5	82	17	72	38	13	54	29	56	53	80	1.20	− 1.2	5	7,971	w.	44	w.	28	7	13	10	4.6	0.0	0.0
Jacksonville	43	209	245	30.05	30.10	.00	65.8	+ 4.5	82	17	74	43	29	58	25	60	58	85	2.27	+ 0.1	8	7,754	sw.	40	sw.	28	15	16	9	5.2	0.0	0.0
Florida Peninsula.							7.34	+ 2.3										76	1.58	− 0.6										3.8		
Key West	22	10	64	30.03	30.05	+ .03	76.1	+ 1.8	84	9	81	57	30	72	16	70	68	78	2.67	+ 0.3	6	7,569	e.	26	e.	23	18	9	3	3.5	0.0	0.0
Miami	25	71	79	30.05	30.08		73.5	+ 1.5	83	11	79	50	30	68	24	68	65	76	0.50	− 2.0	8	6,487	e.	30	e.	22	17	7	6	3.9	0.0	0.0
Sand Key	23	39	72	30.03	30.06	+ .04	75.4		83	9	78	63	30	73	12	70	67	75	4.43		9	11,330	e.	42	ne.	23	15	12	3	3.5	0.0	0.0
Tampa	35	79	92	30.05	30.09	+ .01	70.5	+ 3.7	84	23	79	49	13	62	27	63	60	77	1.58	− 0.1	7	4,631	ne.	26	se.	27	15	8	7	4.4	0.0	0.0
East Gulf States.							60.5	+ 4.6										79	3.51	0.0										5.1		
Atlanta	1,174	100	216	28.86	30.11	− .02	54.7	+ 2.8	75	23	63	33	11	46	27	50	46	79	6.47	+ 3.1	9	8,494	nw.	42	w.	28	11	3	16	5.9	0.0	0 0
Leesburg	279	10	55																													
Macon	370	78	87	29.70	30.10	− .03	58.2	+ 4.9	80	17	68	30	13	48	35	52	48	76	4.56	+ 1.5	8	3,997	nw.	24	w.	28	9	7	14	5.8	0.0	0.0
Thomasville	273	49	58	29.81	30.10	− .02	63.8	+ 5.3	83	18	73	39	13	54	30	56	53	79	3.11	+ 0.5	7	2,958	nw.	22	w.	28	8	9	13	5.7	0.0	0.0
Pensacola	56	149	185	30.04	30.10	− .01	64.2	+ 4.6	78	25	71	42	29	57	25	60	57	84	2.46	− 1.3	5	8,742	ne.	38	n.	27	13	12	5	4.5	0.0	0.0
Anniston	741	9	57	29.32	30.12	.00	55.5	+ 3.6	80	23	66	30	11	44	36				4.35	+ 1.0	10	3,853	nw.	24	nw.	19	12	4	14	5.5	0.0	0.0
Birmingham	700	11	48	29.36	30.13	− .01	57.6	+ 3.5	80	23	68	32	12	48	32	51	47	77	2.14	− 1.2	9	4,684	s.	29	nw.	27	12	4	14	5.4	0.0	0.0
Mobile	57	125	161	30.04	30.10	− .01	63.3	+ 5.8	82	25	72	40	11	54	29	58	56	84	3.79	0.0	6	6,509	n.	34	nw.	27	10	15	5	4.5	0.0	0.0
Montgomery	223	100	112	29.88	30.13	+ .01	59.8	+ 4.1	83	16	70	37	13	50	31	54	51	80	5.77	+ 2.6	7	3,987	nw.	31	n.	14	8	10	12	5.5	0.0	0.0
Corinth	469	6					55.8		81	7	68	30	12	44	41				4.82		12		se.				4	16	10		0.0	0.0
Meridian	375	85	93	29.70	30.10	− .02	59.6	+ 3.4	84	14	71	33	11	48	36	52	49	78	1.23	− 2.9	7	3,400	ne.	25	w.	27	10	12	8	4.5	0.0	0.0
Vicksburg	247	65	73	29.83	30.12	.00	62.4	+ 6.5	84	16	73	36	20	52	29	54	50	73	0.85	− 3.3	3	4,692	se.	36	nw.	19	10	10	10	4.8	0.0	0.0
New Orleans	53	76	84	30.05	30.10	.00	66.6	+ 6.0	86	15	74	50	10	59	22	60	56	79	3.83	0.0	4	4,244	e.	30	w.	13	11	13	6	4.3	0.0	0.0
West Gulf States.							61.9	+ 5.6										70	1.86	− 1.3										4.6		
Shreveport	249	77	93	29.82	30.09	− .02	62.6	+ 7.3	87	16	74	35	10	51	37	54	49	71	1.52	− 2.6	2	5,248	s.	33	nw.	18	13	12	5	4.1	0.0	0.0
Bentonville	1,303	11	44				51.0	+ 4.3	80	5	64	24	12	39	41				1.63		5	2,653	s.	12	sw.	16	13	10	7		T.	0.0
Fort Smith	457	79	94	29.57	30.06	− .05	54.2	+ 4.4	82	4	65	29	10	43	41	47	42	69	5.22	+ 1.9	7	5,564	e.	40	w.	16	13	5	12	5.2	0.0	0.0
Little Rock	357	136	144	29.69	30.08	− .04	55.8	+ 4.3	81	17	66	31	12	46	32	49	44	70	3.89	− 0.7	10	6,314	s.	43	nw.	18	12	3	15	5.6	0.0	0.0
Brownsville	57	4	26				71.8		88	14	82	50	1	61	34				1.22		10		sw.								0.0	0.0
Corpus Christi	20	69	77	30.05	30.07	.00	69.2	+ 5.8	89	13	77	46	20	62	34	64	61	80	0.66	− 1.8	3	7,878	s.	58	ne.	18	14	10	6	4.3	0.0	0.0
Dallas	512	109	117	29.52	30.06		61.6		86	16	74	34	20	50	39				1.19		3	6,412	s.	44	s.	17	16	6	8	4.4	0.0	0.0
Fort Worth	670	106	114	29.32	30.04	− .06	61.6	+ 6.5	86	16	74	33	28	49	38	51	44	60	1.24	− 0.3	3	6,889	sw.	34	sw.	17	17	7	6	3.5	0.0	0.0
Galveston	54	106	114		30.10	+ .01	67.7	+ 4.8	80	14	73	49	20	62	24				1.61	− 2.4	4	6,997	se.	44	nw.	19	15	10	5		0.0	0.0
Groesbeck	461	11	56	29.59	30.08		62.7		88	16	76	31	20	50	41				0.33		4	7,634	s.	43	s.	18	13	9	8	4.2	0.0	0.0
Houston	138	111	121	29.94	30.09		66.7	+ 5.4	89	14	76	42	20	57	31				1.91		8	5,355	se.	38	s.	18	9	16	5	4.6	0.0	0.0
Palestine	510	64	72	29.54	30.08	− .03	63.2	+ 6.3	86	15	74	35	20	52	40	54	46	63	0.43	− 3.2	3	5,371	s.	32	s.	18	17	6	7	4.0	0.0	0.0
Port Arthur	34	58	66	30.04	30.08		64.6		82	14	73	42	20	56	25	60	57	83	3.84		6	5,790	s.	36	n.	19	13	11	6	4.3	0.0	0.0
San Antonio	701	119	132	29.34	30.06	− .02	65.6	+ 6.4	88	14	76	38	20	55	33	57	51	66	1.16	− 0.6	3	4,460	ne.	40	nw.	18	9	11	10	5.4	0.0	0.0
Taylor	582	55	63	29.49	30.11	+ .03	63.6	+ 5.9	88	14	75	33	20	52	41				0.97	− 1.7	7	5,399	s.	35	nw.	18	10	12	8	5.0	0.0	0.0

TABLE 1.—*Climatological data for Weather Bureau stations, November, 1921*—Continued.

Districts and stations.	Elevation of instruments: Barometer above sea level.	Elevation of instruments: Thermometer above ground.	Elevation of instruments: Anemometer above ground.	Pressure: Station, reduced to mean of 24 hours.	Pressure: Sea level, reduced to mean of 24 hours.	Pressure: Departure from normal.	Temperature of the air: Mean max. + mean min. ÷ 2.	Temperature of the air: Departure from normal.	Temperature of the air: Maximum.	Temperature of the air: Date.	Temperature of the air: Mean maximum.	Temperature of the air: Minimum.	Temperature of the air: Date.	Temperature of the air: Mean minimum.	Temperature of the air: Greatest daily range.	Mean wet thermometer.	Mean temperature of the dew-point.	Mean relative humidity.	Precipitation: Total.	Precipitation: Departure from normal.	Precipitation: Days with 0.01 inch or more.	Wind: Total movement.	Wind: Prevailing direction.	Wind: Maximum velocity: Miles per hour.	Wind: Maximum velocity: Direction.	Wind: Maximum velocity: Date.	Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness, tenths.	Total snowfall.	Snow, sleet and ice on ground at end of month.
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F		°F	°F.		°F	°F.	°F.	°F.	%	In.	In.		Miles								0–10	In.	In.
Ohio Valley and Tennessee.							**48.1**	**+ 3.3**										**79**	**6.12**	**+ 2.7**										**6.8**		
Chattanooga	762	189	213	29.30	30.12	− .02	52.7	+ 2.4	76	17	62	30	13	43	31	48	45	80	5.39	+ 1.8	14	5,283	n.	36	w.	19	9	8	13	6.1	0.0	0.0
Knoxville	996	102	111	29.04	30.11	− .02	50.8	+ 3.7	78	18	60	28	13	42	29	46	43	80	4.74	+ 1.1	14	3,979	sw.	36	s.	17	6	6	18	6.9	T.	0.0
Memphis	399	76	97	29.69	30.12	.00	55.8	+ 4.4	80	18	65	30	12	47	30	50	44	70	4.59	0.0	12	6,381	s.	40	nw.	18	12	6	12	5.5	0.0	0.0
Nashville	546	168	191	29.51	30.10	− .02	52.4	+ 3.7	76	18	62	27	12	42	33	47	44	80	5.68	+ 1.8	12	7,440	s.	42	nw.	19	9	8	13	6.0	T.	0.0
Lexington	989	193	230	28.98	30.07	− .05	48.0	+ 3.3	74	18	56	27	12	40	30	......			6.89	+ 3.4	13	11,107	sw.	56	s.	19	9	4	17	6.4	T.	0.0
Louisville	525	219	255	29.49	30.08	− .04	49.5	+ 3.2	71	19	58	26	12	41	33	45	40	75	8.32	+ 4.1	12	9,792	s.	52	n.	28	8	7	15	6.4	T.	0.0
Evansville	431	139	175	29.60	30.08	− .04	49.7	+ 4.4	72	18	58	26	12	41	29	45	40	74	9.24	+ 5.1	13	8,893	sw.	44	w.	11	8	8	14	6.1	T.	0.0
Indianapolis	822	194	230	29.15	30.05	− .05	44.5	+ 2.9	67	6	52	25	12	37	29	41	38	81	8.91	+ 5.4	12	9,096	s.	46	w.	19	5	10	15	7.0	3.8	0.0
Royal Center	736	11	55	29.23	30.04	......	40.0	......	64	17	48	23	15	33	28	......			4.57		13	7,352	sw.	34	n.	1	4	5	21	8.0	2.5	0.0
Terra Haute	575	96	129	29.41	30.03	......	45.8	......	69	6	54	23	12	38	29	41	37	78	5.08	......	10	7,352	nw.	42	nw.	18	5	10	15	6.7	0.9	0.0
Cincinnati	628	11	51	29.38	30.07	− .05	45.8	+ 3.2	69	19	55	25	12	37	32	....	40	82	5.67	+ 2.5	13	6,216	sw.	42	nw.	19	7	7	16	6.7	T.	0.0
Columbus	824	179	222	29.18	30.07	− .04	43.2	+ 1.8	69	18	51	24	12	36	28	40	38	83	5.50	+ 2.4	16	8,390	se.	53	n.	1	4	9	17	7.2	1.8	0.0
Dayton	899	181	216	29.06	30.03	......	44.2	+ 2.1	68	19	52	22	12	36	32	40	38	82	4.88	+ 2.0	12	8,641	sw.	48	s.	18	7	7	16	6.4	1.0	0.0
Elkins	1,947	59	67	28.00	30.09	− .03	44.8	+ 5.2	78	18	55	17	13	35	40	40	36	81	5.30	+ 2.4	18	3,993	w.	25	w.	4	3	8	19	7.7	2.4	0.0
Parkersburg	638	77	84	29.41	30.08	− .04	47.2	+ 4.0	81	18	56	26	13	39	32	42	39	77	5.56	+ 2.7	14	4,532	se.	28	nw.	19	8	4	18	6.9	0.6	0.0
Pittsburgh	842	353	410	29.14	30.06	− .04	44.6	+ 1.7	77	18	51	24	13	38	34	41	38	81	5.06	+ 2.5	16	8,546	sw.	47	nw.	4	2	4	24	8.7	2.5	0.0
Lower Lake Region.							**38.8**	**− 0.3**										**82**	**4.12**	**+ 1.1**										**8.7**		
Buffalo	767	247	280	29.20	30.05	.00	37.6	− 1.4	68	19	42	22	13	32	29	35	32	83	3.77	+ 0.4	20	12,728	w.	58	sw.	19	0	1	29	9.7	8.4	0.0
Canton	448	10	61	29.54	30.04	......	30.8	− 3.1	73	19	37	12	23	24	32	......			2.67	− 0.7	21	8,397	e.	42	w.	19	3	5	22	8.3	14.5	0.8
Oswego	335	76	91	......	30.05	.00	37.6	− 1.5	72	19	43	21	23	32	29	......			5.25	+ 1.8	22	8,965	s.	50	nw.	2	0	4	26	....	6.8	0.0
Rochester	523	86	102	29.48	30.07	+ .02	38.0	+ 0.1	73	19	43	24	13	33	33	35	32	78	4.63	+ 1.9	21	6,420	w.	38	w.	5	1	3	26	9.2	10.7	0.0
Syracuse	597	97	113	29.40	30.06	.00	37.5	− 1.2	74	19	43	22	8	32	31	......			6.58	+ 3.9	20	8,145	w.	44	nw.	5	0	6	24	8.8	5.0	0.0
Erie	714	130	166	29.26	30.04	− .02	41.2	+ 0.1	70	18	46	26	13	36	31	39	36	82	5.21	+ 1.6	17	10,614	ne.	53	ne.	1	0	4	26	9.1	7.2	0.0
Cleveland	762	190	201	29.21	30.05	− .02	42.0	+ 1.6	69	18	47	26	13	37	29	39	36	81	3.93	+ 1.2	15	11,110	s.	54	ne.	1	1	2	27	9.0	0.9	0.0
Sandusky	629	62	103	29.35	30.05	− .03	42.2	+ 1.4	69	19	48	27	12	36	29	......			3.18	+ 0.4	13	10,248	sw.	56	n.	1	1	8	21	8.5	1.8	0.0
Toledo	628	208	243	29.36	30.06	− .01	40.4	+ 0.7	65	19	46	24	12	34	26	37	34	83	3.34	+ 0.7	15	10,775	sw.	50	sw.	4	2	7	21	8.1	2.1	0.0
Fort Wayne	856	113	124	29.12	30.06	......	40.1	− 0.5	63	18	47	19	12	33	23	38	35	85	3.54	......	14	6,841	sw.	38	sw.	4	1	8	21	8.2	3.4	0.0
Detroit	730	218	245	29.25	30.06	.00	38.9	+ 0.3	62	18	44	27	10	34	24	36	33	82	2.59	0.0	13	8,788	sw.	52	n.	1	3	7	20	8.1	8.3	0.0
Upper Lake Region.							**32.9**	**− 1.4**										**82**	**2.33**	**− 0.1**										**8.4**		
Alpena	609	13	92	29.38	30.06	+ .05	33.1	− 0.6	51	18	38	17	12	28	15	31	28	81	2.22	− 0.3	17	7,718	nw.	36	nw.	4	1	9	20	8.2	6.0	0.0
Escanaba	612	54	60	29.38	30.07	+ .04	30.2	− 1.5	49	2	36	5	20	24	35	28	25	81	2.38	+ 0.1	15	6,787	nw.	38	sw.	20	2	3	25	8.6	15.4	0.9
Grand Haven	632	54	89	29.36	30.06	+ .02	36.2	− 1.8	56	17	41	18	12	31	19	34	30	80	2.96	+ 0.4	14	8,143	n.	32	nw.	19	1	5	24	8.8	14.9	0.0
Grand Rapids	707	70	87	29.28	30.07	+ 02	36.7	− 1.4	59	17	42	18	12	32	21	34	30	79	3.64	+ 1.1	10	4,073	e.	23	w.	4	1	2	27	9.1	9.7	0.0
Houghton	684	62	99	29.33	30.08	+ .06	28.7	− 2.8	45	2	33	7	20	24	21	......			1.17	− 1.6	14	6,496	w.	34	w.	29	1	3	26	9.0	7.9	2.0
Lansing	878	11	62	29.08	30.05	......	35.2	− 1.6	59	17	41	13	12	29	23	33	31	87	4.06	+ 1.6	13	4,624	ne.	30	ne.	1	0	5	25	8.9	21.8	0.0
Ludington	637	60	66	29.34	30.06	......	35.4	......	51	4	40	21	12	31	16	33	29	79	1.52	......	12	7,260	se.	31	sw.	10	2	6	22	8.3	7.9	0.0
Marquette	734	77	111	29.27	30.09	+ .07	29.9	− 2.0	46	2	35	6	20	25	29	27	24	82	1.97	− 0.8	16	7,156	w.	33	se.	20	2	3	25	8.7	14.3	3.6
Port Huron	638	70	120	29.83	30.04	− .01	37.0	+ 0.2	61	18	42	18	12	32	24	35	33	87	2.86	+ 0.2	16	8,850	nw.	44	n.	1	1	8	21	8.1	7.9	2.0
Saginaw	641	69	77	29.35	30.06	......	35.5	......	60	17	41	20	12	30	20	34	32	87	2.36	+ 0.1	12	6,130	nw.	35	ne.	1	0	7	23	8.8	7.0	0.0
Sault Sainte Marie	614	11	52	29.36	30.08	+ .07	29.5	− 1.2	46	1	34	10	23	24	19	27	25	83	2.21	− 0.7	21	6,111	e.	33	nw.	24	5	3	22	8.1	13.9	3.5
Chicago	823	140	310	29.16	30.06	− .01	40.8	+ 1.6	65	17	46	22	12	36	17	37	34	78	3.51	+ 1.0	13	9,049	nw.	44	ne.	8	4	8	18	7.5	1.6	0.0
Green Bay	617	109	144	29.38	30.06	+ .02	31.3	− 1.2	49	4	37	10	20	26	39	29	26	82	1.14	− 0.8	11	7,763	n.	34	nw.	4	1	8	21	8.5	8.5	0.0
Milwaukee	681	125	139	29.30	30.06	+ .01	36.2	+ 0.1	56	4	42	19	22	31	20	33	29	77	1.42	− 0.6	10	7,745	n.	33	ne.	1	2	8	20	8.1	1.6	0.0
Duluth	1,133	11	47	28.83	30.10	+ .06	23.2	− 6.1	48	4	29	−11	20	17	25	21	19	88	0.70	− 0.9	7	8,293	nw.	37	nw.	4	4	6	20	7.6	8.2	2.0
North Dakota.							**21.5**	**− 3.0**										**83**	**0.61**	**− 0.2**										**7.3**		
Moorhead	940	50	58	29.08	30.14	+ .06	21.8	− 2.6	61	3	29	−16	20	14	31	20	16	81	0.52	− 0.5	10	5,812	n.	21	s.	12	4	7	19	7.3	4.5	0.6
Bismarck	1,674	8	57	28.29	30.15	+ .08	22.6	− 3.4	66	3	30	−12	19	15	37	20	18	84	0.84	+ 0.2	8	5,826	nw.	32	nw.	12	4	13	13	6.7	8.7	3.0
Devils Lake	1,482	11	44	28.46	30.10	+ .04	18.6	− 4.0	60	3	26	−17	19	12	29	17	14	85	0.43	− 0.3	6	6,874	w.	25	ne.	7	4	8	18	7.3	5.1	1.0
Ellendale	1,457	10	56	28.50	30.12	......	20.2	......	65	3	29	−17	19	12	40	......			0.65	......	8	8,670	nw.	42	nw.	13	4	10	16	7.6	6.4	1.1
Grand Forks	835	12	80	......	......	......	18.9	......	59	3	27	−23	21	11	31	......			0.36	......	6	......	nw.	32	s.	27	2	6	22	.....	3.6	2.6
Williston	1,878	41	48	28.02	30.07	+ .01	23.0	− 2.2	65	3	32	−20	20	14	37	20	17	82	0.65	0.0	10	5,503	w.	37	se.	22	3	9	18	7.7	6.5	0.4
Upper Mississippi Valley.							**37.7**	**0.0**										**81**	**2.44**	**+ 0.5**										**7.3**		
Minneapolis	918	102	208	29.06	30.08	......	27.5	......	54	1	33	− 3	20	22	29	......			1.58	+ 0.4	8	7,581	nw.	33	s.	28	6	5	19	7.4	16.6	2.4
St. Paul	837	236	261	29.17	30.10	+ .04	27.0	− 3.9	53	1	33	− 5	20	21	33	......			1.58	+ 0.3	8	7,260	nw.	33	w.	2	5	6	19	7.4	18.1	2.5
La Crosse	714	11	48	29.28	30.08	+ .01	30.2	− 3.4	55	4	37	7	12	23	25	......			1.54	0.0	12	3,442	n.	19	nw.	4	4	4	22	8.0	10.5	0.0
Madison	974	70	78	29.00	30.09	+ .03	31.9	− 2.4	54	4	37	12	22	26	19	30	28	87	1.55	− 0.2	10	7,330	n.	30	n.	27	2	4	24	8.3	12.3	0.0
Wausau	1,247	4	....	28.68	30.06	......	26.7	......	50	1	33	− 3	20	20	33	......			1.48	......	11	......	nw.	......			2	1	27	8.7	17.0	1.8
Charles City	1,015	10	49	28.98	30.09	+ .01	30.1	− 2.9	56	4	37	3	12	24	23	28	26	88	0.96	− 0.4	8	4,577	nw.	24	s.	20	5	5	20	7.7	11.2	0.0
Davenport	606	71	79	29.40	30.07	− .01	36.8	− 0.7	64	4	43	13	12	31	24	34	31	82	0.77	− 1.0	8	5,090	e.	25	e.	8	4	5	21	7.6	5.4	0.0
Des Moines	861	84	97	29.14	30.07	− .01	35.8	− 1.0	64	4	43	14	22	28	28	32	28	77	0.35	− 1.1	6	4,823	n.	20	sw.	15	8	6	16	6.6	0.4	0.0
Dubuque	698	81	96	29.33	30.10	+ .03	34.2	− 1.8	59	4	40	14	12	28	24	32	29	82	0.91	− 0.9	7	4,638	nw.	24	nw.	4	5	4	21	7.7	7.0	0.0
Keokuk	614	64	78	29.38	30.08	− .01	40.3	+ 0.9	68	16	48	17	12	33	27	36	33	79	1.12	− 0.7	9	5,010	n.	22	n.	8	4	9	17	7.4	1.5	0.0
Cairo	356	87	93	29.68	30.07	− .05	51.2	+ 4.3	74	18	60	31	12	42	34	45	41	74	11.18	+ 7.2	14	6,908	s.	44	sw.	18	5	10	15	6.5	T.	0.0
Peoria	609	11	45	29.39	30.07	− .02	39.9	+ 2.4	65	4	47	15	12	33	27	35	35	88	3.43	+ 0.8	12	4,920	nw.	23	ne.	9	4	10	16	7.3	4.2	0.0
Springfield, Ill	644	10	91	29.36	30.05	− .05	43.0	+ 2.3	67	6	50	25	12	36	25	39	36	82	3.25	+ 0.6	10	5,849	s.	26	nw.	11	5	10	15	6.8	0.1	0.0
Hannibal	534	74	109	29.48	30.06	− .03	42.6	+ 2.1	70	6	51	23	12	35	25	......			1.50	− 0.4	8	5,690	nw.	24	n.	8	6	8	16	6.8	0.7	0.0
St. Louis	567	265	303	29.44	30.06	− .04	47.3	+ 3.9	73	17	56	28	12	39	31	41	36	69	4.43	+ 1.6	8	8,936	s.	40	n.	8	7	11	12	6.0	T.	0.0
Missouri Valley.							**37.8**	**+ 0.4**										**76**	**0.55**	**− 0.7**										**5.8**		
Columbia, Mo.	781	11	84	29.21	30.06	− .03	43.7	+ 1.3	75	16	54	17	12	34	31	......			1.34	− 1.0	6	5,522	se.	33	nw.	11	9	9	12	5.9	0.5	0.0
Kansas City	963	161	181	29.01	30.07	− .02	44.8	+ 3.3	76	16	54	23	12	35	35	38	31	65	0.07	− 1.8	4	7,623	n.	38	nw.	27	14	9	7	4.6	0.5	0.0
St. Joseph	967	11	49	29.00	30.06	......	41.8	......	72	16	52	21	22	32	31	35	30	72	0.03	......	1	5,551	nw.	31	nw.	27	13	10	7	4.5	T.	0.0
Springfield, Mo.	1,324	98	104	28.64	30.06	− .04	48.4	+ 4.0	76	16	59	23	12	38	34	42	37	72	2.46	− 0.2	10	7,905	se.	31	nw.	18	14	9	7	4.2	T.	0.0
Iola	984	11	50	29.00	30.06	− .03	45.6	+ 2.6	80	16	58	22	12	34	39	......			0.13	− 1.2	2	5,091	s.	25	n.	8	13	4	13	5.6	0.5	0.0
Topeka	987	92	107	......	......	......	43.8	+ 2.1	75	4	55	20	22	33	33	......			0.01	− 1.2	1	6,895	n.	35	n.	8	10	13	7	4.9	T.	0.0
Drexel	1,299	10	53	28.65	30.07	......	34.8	......	66	4	45	8	22	25	34	30	27	81	0.16	......	5	7,061	n.	33	s.	15	7	12	11	6.2	1.4	0.0
Lincoln	1,189	11	84	28.77	30.08	.00	37.5	− 0.5	69	4	48	10	22	27	39	33	29	78	0.02	− 0.8	2	6,875	n.	38	nw.	26	10	8	12	5.8	0.1	0.0
Omaha	1,105	115	122	28.88	30.09	+ .01	36.9	− 0.8	65	4	45	11	22	29	33	32	28	75	0.09	− 1.0	3	6,198	nw.	28	n.	8	9	8	13	6.0	0.5	0.0
Valentine	2,598	47	54	27.30	30.09	+ .01	32.8	− 0.9	72	3	44	0	22	22	42	27	23	77	0.68	0.0	10	6,099	w.	34	s.	20	5	12	13	6.2	7.9	0.0
Sioux City	1,135	94	164	28.85	30.11	+ .03	31.6	− 2.7	62	4	40	4	22	24	26	29	25	79	0.58	− 0.4	8	7,120	s.	32	s.	15	8	5	17	6.9	6.3	0.3
Huron	1,306	59	74	28.69	30.14	+ .06	27.0	− 0.4	67	3	36	− 8	19	18	39	24	21	83	0.42	− 0.2	8	6,096	nw.	28	se.	22	7	10	13	6.0	5.6	T.
Pierre	1,572	70	75	28.39	30.11	+ .03	29.4	− 2.2	71	3	37	− 4	19	22	39	26	21	75	0.49	+ 0.1	8	5,710	nw.	30	nw.	12	2	10	18	7.4	3.6	T.
Yankton	1,233	49	57	28.75	30.11	+ .03	31.9	− 1.6	68	3	41	1	19	23	37	......			0.32	− 0.5	8	5,343	nw.	24	s.	25	5	11	14	7.1	2.8	0.0

TABLE 1.—*Climatological data for Weather Bureau stations, November, 1921*—Continued.

Districts and stations.	Elevation of instruments. Barometer above sea level.	Thermometer above ground.	Anemometer above ground.	Pressure. Station, reduced to mean of 24 hours.	Sea level, reduced to mean of 24 hours.	Departure from normal.	Temperature of the air. Mean max. + mean min. ÷ 2.	Departure from normal.	Maximum.	Date.	Mean maximum.	Minimum.	Date.	Mean minimum.	Greatest daily range.	Mean wet thermometer.	Mean temperature of the dew-point.	Mean relative humidity.	Precipitation. Total.	Departure from normal.	Days with 0.01 inch or more.	Wind. Total movement.	Prevailing direction.	Maximum velocity. Miles per hour.	Direction.	Date.	Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness, tenths.	Total snowfall.	Snow, sleet and ice on ground at end of month.
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F		°F	°F.		°F	°F.	°F.	°F.	%	In.	In.		Miles								0–10	In.	In.
Northern Slope.							33.0	+ 0.8										67	1.26	+ 0.4										6.3		
Billings	3,140	5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Havre	2,505	11	44	27.36	30.08	+ .05	25.8	− 4.8	70	3	35	−26	19	17	40	23	20	81	1.09	+ 0.3	9	4,646	sw.	28	sw.	30	3	7	20	7.8	8.4	0.0
Helena	4,110	87	112	25.77	30.07	− .03	31.2	− 1.5	62	3	41	−13	19	22	32	26	20	67	1.65	+ 0.9	12	4,902	sw.	35	sw.	26	0	6	24	8.4	23.8	3.7
Kalispell	2,973	48	56	......	30.05	− .02	30.3	− 1.7	54	1	37	−12	19	24	24	.....	.....	.....	2.39	+ 0.5	12	3,475	nw.	22	nw.	21	3	4	23	....	18.3	3.0
Miles City	2,371	26	48	27.48	30.11	+ .04	30.8	− 0.1	70	3	40	−15	19	22	34	26	22	79	2.23	+ 1.6	11	4,030	se.	30	nw.	1	10	11	9	5.1	14.2	2.5
Rapid City	3,259	50	58	26.60	30.11	+ .03	33.3	− 0.3	72	3	45	− 3	19	22	36	27	19	60	0.63	+ 0.2	8	5,927	w.	36	n.	28	3	11	16	7.0	6.6	0.0
Cheyenne	6,088	84	101	23.97	30.01	− .06	38.6	+ 3.7	67	4	50	13	18	27	36	31	21	51	0.34	− 0.1	4	9,095	w.	53	w.	21	11	11	8	5.2	3.6	T.
Lander	5,372	60	68	24.61	30.05	− .05	36.8	+ 8.1	70	3	51	− 1	18	23	42	29	21	58	0.43	− 0.2	3	4,002	sw.	60	sw.	25	9	17	4	4.9	4.7	0.0
Sheridan	3,790	10	47	26.99	30.10	......	29.6	......	77	3	42	− 7	19	17	51	25	19	70	1.38	......	7	3,125	nw.	37	nw.	26	4	14	12	6.5	13.2	3.7
Yellowstone Park	6,200	11	48	23.83	30.06	+ .05	31.9	+ 2.6	60	4	42	− 5	19	22	40	26	20	66	2.55	+ 1.1	14	6,089	s.	41	s.	22	5	8	17	6.9	23.7	8.8
North Platte	2,821	11	51	27.12	30.12	+ .04	38.0	+ 2.9	76	3	52	6	22	24	45	30	24	72	0.04	− 0.4	2	4,757	w.	32	nw.	26	10	8	12	5.3	0.1	0.0
Middle Slope.							44.7	+ 3.0										59	0.28	− 0.7										4.0		
Denver	5,292	106	113	24.72	30.03	− .03	43.7	+ 4.5	72	3	56	13	19	31	33	34	22	48	0.57	0.0	3	5,119	s.	32	nw.	26	17	8	5	4.0	6.5	0.0
Pueblo	4,685	80	86	25.29	30.04	− .01	42.8	+ 3.5	77	7	59	5	19	27	50	33	22	53	0.72	+ 0.4	2	3,857	nw.	30	nw.	26	15	13	2	3.8	7.2	0.0
Concordia	1,392	50	58	28.58	30.09	+ .01	41.1	+ 1.2	78	5	53	13	23	29	40	34	27	67	0.08	− 0.9	2	5,169	n.	36	nw.	26	8	12	10	5.7	T.	0.0
Dodge City	2,509	11	51	27.44	30.10	+ .03	43.6	+ 3.1	80	4	59	9	23	28	49	33	24	59	T.	− 0.6	0	6,150	nw.	29	nw.	26	21	4	5	2.5	T.	0.0
Wichita	1,358	139	158	28.50	30.04	− .04	45.6	+ 1.8	80	4	56	20	22	35	33	38	31	64	T.	− 1.2	0	8,560	s.	38	s.	12	15	5	10	4.5	T.	0.0
Altus	1,410	5	.....	......	......	......	53.0	......	86	4	69	19	19	37	46	.....	.....	.....	T.	......	0	......	se.	.....	.....	.....	25	1	4	....	0.0	0.0
Broken Arrow	765	11	52	29.22	30.07	......	50.3	......	80	16	63	25	10	37	38	.....	.....	.....	1.28	......	3	9,106	n.	39	w.	8	15	7	8	4.3	0.0	0.0
Muskogee	652	4	.....	......	......	......	53.8	......	84	4	68	24	10	40	43	.....	.....	.....	1.26	......	3	......	w.	.....	.....	.....	10	16	4	....	0.0	0.0
Oklahoma City	1,214	10	47	28.77	30.07	− .01	51.5	+ 3.6	84	5	65	24	19	38	41	41	33	61	0.33	− 1.9	1	9,411	s.	42	s.	16	16	10	4	3.2	0.0	0.0
Southern Slope.							55.8	+ 4.8										47	0.09	− 1.1										3.2		
Abilene	1,738	10	52	28.24	30.06	− .01	57.4	+ 4.8	85	15	72	25	19	42	46	45	34	50	0.01	− 1.2	1	6,393	s.	27	sw.	23	15	6	9	3.9	0.0	0.0
Amarillo	3,676	10	49	26.29	30.04	− .01	51.0	+ 7.2	80	3	67	17	19	35	44	39	30	56	T.	− 1.1	0	7,318	sw.	32	s.	12	22	8	0	2.8	T.	0.0
Del Rio	944	64	71	29.07	30.06	+ .01	63.0	+ 3.7	90	14	75	40	20	51	36	.....	.....	.....	0.36	− 0.8	3	4,775	se.	31	n.	18	15	8	7	4.0	0.0	0.0
Roswell	3,566	75	85	26.40	30.03	.00	51.6	+ 3.5	80	21	70	13	19	33	53	37	18	34	T.	− 1.2	0	4,586	s.	33	nw.	18	20	9	1	2.3	0.0	0.0
Southern Plateau.							51.9	+ 3.0										45	0.05	− 0.5										2.1		
El Paso	3,762	110	133	26.25	30.04	+ .04	54.4	+ 3.5	75	5	69	24	19	40	41	40	22	32	0.22	− 0.4	3	5,993	w.	38	nw.	18	21	8	1	1.8	0.0	0.0
Santa Fe	7,013	57	66	23.28	30.07	+ .04	43.0	+ 4.8	65	6	55	14	19	31	30	30	18	43	T.	− 0.8	0	5,544	n.	33	sw.	17	22	6	2	2.1	T.	0.0
Flagstaff	6,908	10	59	23.41	30.07	+ .05	40.2	+ 5.6	66	8	57	7	18	23	49	29	.....	.....	0.33	......	4	......	w.	34	se.	16	20	7	3	....	0.0	0.0
Phoenix	1,108	76	81	28.84	30.00	+ .02	60.9	+ 2.2	89	2	78	30	19	43	44	46	36	49	0.04	− 0.9	1	2,954	e.	19	w.	17	21	7	2	2.3	0.0	0.0
Yuma	141	9	54	29.86	30.01	+ .03	63.2	+ 1.3	89	4	78	36	19	48	38	50	40	51	0.00	− 0.3	0	2,921	n.	22	nw.	28	23	6	1	1.9	0.0	0.0
Independence	3,957	9	41	26.06	30.12	+ .07	49.8	+ 0.6	75	13	65	20	18	35	38	37	21	38	T.	− 0.3	0	2,952	nw.	25	sw.	15	21	7	2	2.3	0.0	0.0
Middle Plateau.							43.2	+ 3.7										51	0.42	− 0.4										4.1		
Reno	4,532	74	81	25.54	30.12	+ .01	45.0	+ 4.0	74	2	60	9	18	30	45	35	23	48	0.20	− 0.9	4	4,082	w.	37	w.	15	15	12	3	3.7	2.3	0.0
Tonopah	6,090	12	20	24.16	30.10	......	46.1	......	68	1	54	14	18	38	23	35	21	38	0.06	− 0.8	1	4,727	w.	30	nw.	17	16	11	3	2.9	0.0	0.0
Winnemucca	4,344	18	56	25.69	30.14	.00	41.0	+ 3.5	74	3	58	2	18	24	55	32	22	55	0.64	− 0.1	4	5,981	sw.	33	sw.	20	13	6	11	5.2	T.	0.0
Modena	5,479	10	43	24.67	30.09	+ .01	41.8	+ 2.8	70	4	58	8	18	25	43	30	19	50	0.18	− 0.4	3	6,797	w.	41	s.	15	21	6	3	2.6	T.	0.0
Salt Lake City	4,360	163	203	25.69	30.09	− .03	45.9	+ 5.5	67	3	55	22	18	37	27	38	29	55	1.04	− 0.4	6	4,258	se.	30	sw.	21	11	6	13	5.5	4.9	0.0
Grand Junction	4,602	60	68	25.45	30.08	.00	42.4	+ 2.5	66	15	55	20	19	30	37	34	25	58	0.42	− 0.1	4	3,102	se.	24	sw.	16	14	9	7	4.5	0.5	0.0
Northern Plateau.							41.5	+ 2.8										70	2.54	+ 1.2										7.2		
Baker	3,471	48	53	26.46	30.08	− .08	39.7	+ 4.8	65	3	49	16	17	30	35	35	30	71	2.47	+ 1.3	12	4,943	se.	28	s.	22	6	6	18	7.0	8.6	0.0
Boise	2,739	78	86	27.22	30.11	− .06	44.7	+ 5.1	67	4	54	24	18	35	31	39	31	62	3.27	+ 2.4	10	3,361	se.	32	nw.	25	9	7	14	6.3	0.6	0.0
Lewiston	757	40	48	29.25	30.07	− .05	41.4	+ 0.5	65	1	50	22	21	33	33	.....	.....	.....	2.45	+ 1.1	16	1,798	e.	26	w.	30	4	6	20	7.6	15.9	0.0
Pocatello	4,477	60	68	25.51	30.08	− .06	42.4	+ 6.1	68	3	52	22	18	33	37	35	28	62	0.71	+ 0.2	8	7,417	sw.	36	sw.	19	9	10	11	6.0	0.1	0.0
Spokane	1,929	101	110	27.97	30.06	− .04	36.8	− 0.5	60	6	44	− 1	19	30	26	35	32	83	2.40	+ 0.1	14	4,182	sw.	32	sw.	25	0	5	25	8.7	10.5	0.0
Walla Walla	991	57	67	28.98	30.07	− .06	43.9	+ 1.0	67	6	51	15	20	36	32	39	34	71	3.91	+ 1.8	14	4,062	s.	30	sw.	14	4	7	19	7.5	19.9	0.0
North Pacific Coast Region.							46.7	+ 2.4										89	8.40	+ 1.5										8.6		
North Head	211	11	56	29.75	29.98	− .07	49.2	+ 1.5	67	3	53	37	17	45	22	48	47	93	10.52	+ 4.2	23	13,179	s.	84	s.	21	3	5	22	8.2	0.0	0.0
Port Angeles	29	8	53	29.95	29.98	......	42.0	+ 4.8	57	4	46	27	21	38	16	.....	.....	.....	6.35	+ 1.9	22	3,439	s.	24	w.	11	0	1	29	9.5	9.2	0.0
Seattle	125	215	250	29.88	30.01	− .03	45.4	+ 0.8	61	5	50	28	20	41	20	44	43	91	6.60	+ 0.7	22	7,384	se.	47	s.	22	0	5	25	9.1	7.3	0.0
Tacoma	213	113	120	29.78	30.02	− .02	45.6	+ 1.5	62	4	50	29	21	41	21	.....	.....	.....	6.82	− 1.7	21	4,699	sw.	29	sw.	26	0	4	26	8.5	11.0	0.0
Tatoosh Island	86	7	57	29.83	29.93	− .04	46.5	+ 0.9	62	4	50	30	20	43	20	45	43	90	12.02	− 0.1	23	13,855	e.	72	s.	22	0	4	26	8.6	T.	0.0
Yakima	1,071	4	.....	......	......	......	36.9	......	68	6	48	6	23	26	35	.....	.....	.....	2.33	......	7	......	nw.	.....	.....	.....	9	8	13	....	25.4	6.0
Medford	1,425	4	.....	......	......	......	......	......	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	......	......	.....	......	.....	.....	.....	.....	.....	.....	.....	....	.....	.....
Portland, Oreg.	153	68	106	29.88	30.04	− .06	48.8	+ 3.2	68	5	54	29	20	43	23	46	44	86	10.04	+ 3.6	19	4,408	se.	28	s.	21	1	3	26	8.9	0.0	0.0
Roseburg	510	9	57	29.55	30.11	− .01	49.8	+ 4.2	66	6	56	33	18	44	20	47	44	84	6.46	+ 2.1	17	2,298	s.	24	sw.	22	0	16	14	7.2	0.0	0.0
Middle Pacific Coast Region.							54.6	+ 1.1										73	2.38	− 0.7										5.0		
Eureka	62	73	89	30.08	30.15	+ .03	52.0	+ 1.0	77	3	58	33	18	47	32	49	47	86	6.21	+ 0.5	12	4,067	se.	30	nw.	27	2	8	20	7.7	0.0	0.0
Mount Tamalpais	2,375	11	18	......	......	......	......	......	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	......	......	.....	......	.....	.....	.....	.....	.....	.....	.....	....	.....	.....
Point Reyes Light	490	7	18	29.55	30.06	......	53.9	+ 0.9	78	4	59	43	18	49	27	.....	.....	.....	1.70	......	8	12,633	nw.	70	nw.	27	9	6	15	5.8	0.0	0.0
Red Bluff	332	50	56	29.74	30.11	.00	54.0	+ 0.6	84	9	66	27	19	42	41	47	39	62	1.52	− 1.7	7	2,887	nw.	24	nw.	28	15	6	9	4.2	0.0	0.0
Sacramento	69	106	117	30.04	30.11	+ .02	54.8	+ 1.4	80	6	65	31	20	44	33	49	43	68	1.09	− 1.1	4	3,697	se.	18	se.	30	19	3	8	3.3	0.0	0.0
San Francisco	155	208	243	29.94	30.11	+ .02	57.8	+ 2.3	79	4	64	45	19	52	23	52	48	77	1.43	− 1.0	5	4,361	w.	26	nw.	27	14	7	9	4.9	0.0	0.0
San Jose	141	12	110	29.96	30.12	......	54.9	+ 0.5	85	4	68	30	20	42	41	.....	.....	.....	1.65	− 0.2	7	3,100	s.	22	sw.	3	16	5	9	4.0	0.0	0.0
South Pacific Coast Region.							59.8	+ 2.3										62	0.19	− 1.0										3.5		
Fresno	327	80	98	29.75	30.11	+ .05	57.0	+ 2.4	85	3	69	32	18	45	35	47	36	52	0.26	− 0.8	1	3,090	nw.	36	nw.	27	18	7	5	3.1	0.0	0.0
Los Angeles	338	159	191	29.69	30.06	+ .04	63.2	+ 2.9	94	3	73	45	18	53	34	53	46	63	0.05	− 1.4	1	3,470	ne.	21	n.	17	15	11	4	3.4	0.0	0.0
San Diego	87	62	70	29.95	30.04	+ .02	60.4	+ 1.4	93	3	68	45	22	52	38	54	49	73	0.30	− 0.5	3	3,538	nw.	25	w.	28	16	8	6	3.7	0.0	0.0
San Luis Obispo	201	32	40	29.88	30.10	+ .04	58.8	+ 2.5	92	4	72	34	21	45	48	48	40	61	0.16	− 1.5	2	2,505	n.	20	ne.	22	15	11	4	3.8	0.0	0.0
West Indies.																																
San Juan, P. R.	82	8	54	29.91	29.99	......	77.8	......	88	20	83	70	19	73	16	.....	.....	.....	4.27	− 2.6	17	8,164	e.	33	e.	8	13	13	4	4.4	0.0	0.0
Panama Canal.																																
Balboa Heights	118	7	97	......	......	......	......	......	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	......	......	.....	......	.....	.....	.....	.....	.....	.....	.....	....	.....	.....
Colon	25	5	71	......	......	......	......	......	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	......	......	.....	......	.....	.....	.....	.....	.....	.....	.....	....	.....	.....
Alaska.																																
Juneau	80	11	49	......	......	......	33.2	......	47	1	37	14	20	29	14	30	22	66	5.96	......	13	4,542	ne.	30	ne.	22	13	4	13	5.2	2.8	0.0

TABLE II.—*Data furnished by the Canadian Meteorological Service, November, 1921.*

Stations.	Altitude above mean sea level, Jan. 1, 1919.	Pressure.			Temperature of the Air.						Precipitation.		
		Station reduced to mean of 24 hours.	Sea level reduced to mean of 24 hours.	Departure from normal.	Mean max.+mean min.÷2.	Departure from normal.	Mean maximum.	Mean minimum.	Highest.	Lowest.	Total.	Departure from normal.	Total snowfall.
	Feet.	*In.*	*In.*	*In.*	°*F*	°*F*	°*F*	°*F*	°*F*	°*F*	*In.*	*In.*	*In.*
St. Johns, N. F	125												
Sydney, C. B. I	48	29.94	29.99	+0.04	34.9	−2.2	40.0	29.9	60	20	3.64	−1.80	13.0
Halifax, N. S	88	29.90	30.01	.00	35.8	−1.5	42.4	29.1	63	15	7.64	+1.98	17.4
Yarmouth, N. S	65	29.93	30.00	− .02	37.9	−2.0	43.2	32.7	57	21	4.91	+0.35	5.3
Charlottetown, P. E. I	38	29.97	30.01	+ .05	32.6	−2.9	37.4	27.9	56	14	4.20	+0.23	8.3
Chatham, N. B	28	30.01	30.03	+ .06	28.4	−2.6	34.5	22.4	56	10	4.02	+0.27	35.2
Father Point, Que	20	30.03	30.05	+ .09	25.6	−3.3	31.6	19.6	56	2	2.41	−0.70	18.1
Quebec, Que	296	29.75	30.09	+ .07	27.7	−1.3	32.7	22.7	60	6	3.31	−0.45	23.2
Montreal, Que	187	29.85	30.07	+ .04	29.7	−2.1	34.6	24.8	64	12	3.07	−0.67	20.6
Stonecliffe, Ont	489												
Ottawa, Ont	236	29.81	30.09	+ .07	29.2	−2.5	36.2	22.3	66	10	3.37	+0.83	25.9
Kingston, Ont	285	29.74	30.06	+ .02	34.1	−0.9	40.3	28.0	62	14	2.24	−1.00	9.8
Toronto, Ont	379	29.64	30.06	+ .02	36.3	+0.7	42.0	30.7	62	21	1.44	−1.70	7.5
Cochrane, Ont	930												
White River, Ont	1,244	28.68	30.04	+ .06	16.5	−4.0	25.9	7.2	42	−19	2.21	+0.36	21.9
Port Stanley, Ont	592	29.40	30.06	+ .01	36.6	−0.2	42.8	30.4	56	20	3.58	+0.21	4.7
Southampton, Ont	656	29.31			35.4	+0.4	40.5	30.3	59	20	2.78	−0.92	4.1
Parry Sound, Ont	688	29.32	30.03	+ .02	30.2	−1.9	37.2	23.2	58	8	4.12	−0.25	8.8
Port Arthur, Ont	644	29.37	30.11	+ .11	22.3	−1.7	28.8	15.8	48	−10	1.20	−0.13	10.9
Winnipeg, Man	760	29.24	30.11	+ .07	18.2	+0.2	24.5	12.0	46	−14	0.86	−0.22	8.5
Minnedosa, Man	1,690	28.20	30.11	+ .07	14.8	−2.5	22.1	7.7	52	−23	1.00	0.00	10.0
La Pas, Man	860												
Qu'Appelle, Sask	2,115	27.69	30.04	+ .04	16.5	−2.3	24.1	8.9	56	−26	1.64	+0.75	16.4
Medicine Hat, Alb	2,144												
Moose Jaw, Sask	1,759												
Swift Current, Sask	2,392	27.40	30.13	+ .11	21.5	−1.7	29.3	13.7	66	−20	0.43	−0.26	4.2
Calgary, Alb	3,428												
Banff, Alb	4,521												
Edmonton, Alb	2,150												
Prince Albert, Sask	1,450	28.43	30.07	+ .04	14.1	−1.3	21.0	7.2	52	−22	1.90	+1.07	19.0
Battleford, Sask	1,592	28.22	30.03	+ .01	16.9	+0.6	24.2	9.6	55	−15	0.84	+0.26	8.4
Kamloops, B. C	1,262												
Victoria, B. C	230	29.72	29.98	− .01	43.7	+0.5	47.3	40.2	58	24	6.09	−0.88	3.0
Barkerville, B. C	4,180												
Triangle Island, B. C	680												
Prince Rupert, B. C	170												
Hamilton, Ber	151	30.01	30.17	+ .12	70.9	+2.2	76.3	65.5	80	61	6.27	+1.89	

SEISMOLOGICAL REPORTS FOR NOVEMBER, 1921.

W. J. HUMPHREYS, Professor in Charge.

[Weather Bureau, Jan. 3, 1922.]

TABLE 1.—*Noninstrumental earthquake reports, November, 1921.*

Day.	Approximate time, Greenwich civil.		Station.	Approximate latitude.		Approximate longitude.		Intensity Rossi-Forel.	Number of shocks.	Duration.	Sounds.	Remarks.	Observer.
1921.	*H.*	*m.*	CALIFORNIA.	°	′	°	′			*Sec.*			
2	23	22	Venice	33	58	118	28	4	4	1½	Rumbling	Believed due to guns at San Pedro.	F. D. Young.
3	0	59½	do	33	58	118	28	4	6	2	do	do	Do.
15	14	25	Bakersfield	35	22	119	00	3	1		None		Western Union.
17	19	58½	Calexico	32	41	115	30	5	2	5	Loud	Cracked two buildings	W. S. Pratt.
17	22	11	Trona	35	45	117	15	2	1		None	Felt by several	H. de Ropp; R. W. Flory.
17	23	23½	Calexico	32	41	115	30	4	2	2 *ca.*	Rumbling	Felt by many	W. S. Pratt.
18	16	51	Calipatria	33	08	115	30	2–3	3	Few.	do	Felt by several	J. S. Davis.
26	6	21	Calexico	32	41	115	30	3	2	½	do	do	W. S. Pratt.
29	7	01	do	32	41	115	30	2	1	2	do	Felt by many	Do.
29	9	20	Eureka	40	45	124	15	3	1	2	None	do	L. B. Cooper.
			UTAH.										
1	15	35	Greenwich	38	30	111	50	5	2	1	do	Felt by several	W. L. Price.

TABLE 2.—*Instrumental seismological reports, November, 1921.*

Time used: Mean Greenwich, midnight to midnight. Nomenclature: International.

[For significance of symbols, see REVIEW for January, 1921, p. 47.]

ALASKA. *U. S. C. & G. S. Magnetic Observatory, Sitka.*

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1921.			*H. m. s.*	*Sec.*	*μ*	*μ*	*Km.*	
Nov. 11	....	i_E	18 59 47	10				Only a trace lasting less than a minute on N.
		e_N	19 00 13					
		L_E	19 18 33	30				
		M_E	19 20 40		10			
		C_E	19 24 ..	16				
		F_E	19 32 ..					

ARIZONA. *U. S. C. & G. S. Magnetic Observatory, Tucson.*

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1921.			*H. m. s.*	*Sec.*	*μ*	*μ*	*Km.*	
Nov. 2	....	P_N	2 52 24	4				Timing apparatus out of order. Probably in Mexico.
		S_N	2 56 11	5				
		L_N	2 58 13	9				
		M_N	2 58 37	5		20		
		C_N	3 01 ..					
		F_N	3 11 ..					
2	....	P_N	3 42 28	4				Timing apparatus out of order.
		S_N	3 46 05	5				
		L_N	3 48 02	10				
		M_N	3 50 40	11		100		
		C_N	3 52 ..					
		F_N	4 13 ..					
15	....	P_N	20 55 26	5				P doubtful. E not in operation.
		S_N	21 00 22					
		L_N	21 04 51	8				
		M_N	21 05 00	11		10		
		F_N	21 24 ..					
17	....	e_N	22 15 37	4				Not far distant. E not in operation.
		M_N	22 16 11	5		20		
		F_N	22 21 ..					

DISTRICT OF COLUMBIA. *Georgetown University, Washington.*

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1921.			*H. m. s.*	*Sec.*	*μ*	*μ*	*Km.*	
Nov. 2	....	e_E?	3 57 ..					Very heavy micros.
		e_N?	3 57 ..					
		F	4 10 ..					
11	....	e	18 55 25					Heavy micros. S_E does not show. P_Z 18:55:21. F lost in second quake.
		S_N	19 06 32					
		eL_E?	19 27 42					
		eL_N	19 26 42					
		L_E	19 41 33	27				
		L_N	19 42 26	23				
15	....	e_E	8 47 29					Very heavy micros. No distinct M.
		e_N	8 47 26					
		eL_E?	8 52 31					
		eL_N?	8 52 36					
		L_E	8 55 ..	20				
		L_N	9 01 16	11				
		F?						
15	....	eP_E	20 50 00					
		eP_N	20 50 00					
		i	20 56 11					
		S_E	21 00 14					
		iS_N	21 00 15					
		eL_N?	21 17 12					
		L_E	21 21 15	24				
		L_N	21 26 18	15				
		L_E	21 33 08	15				
		L_N	21 42 16	16				
		F?	22 ca.					
			VERTICAL.					
		eP_Z	*20 50 00*					
		i_Z	*20 56 ..*					
		S_Z	*21 00 20*					
		eL_Z	*21 17 12*	*21*				
		L_Z	*21 26 ..*	*13*				
		F_Z	*21 50 ..*					

DISTRICT OF COLUMBIA. *U. S. Weather Bureau, Washington.*

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1921.			*H. m. s.*	*Sec.*	*μ*	*μ*	*Km.*	
Nov. 11	....	e	15 12 ..					
		F	15 20 ..					
11	....	P	18 55 33					S and beginning of L not visible.
		L	19 40 ..	25				
		L	19 52 ..	20				
		F	20 50 ..					
13	....	P	8 46 43				4,200	Nothing on E.
		S	8 52 30					
		L?	8 57 20	20				
		F	9 10 ..					
15	....	P	20 50 57				7,900	
		PR1	20 54 00					
		PR2	20 57 08					
		S	21 00 14					
		eL	21 17 ..					
		L	20 27 ..	16				
		F	21 50 ..					

ILLINOIS. *U. S. Weather Bureau, Chicago.*

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1921.			*H. m. s.*	*Sec.*	*μ*	*μ*	*Km.*	
Nov. 2	....	P	3 43 40				3,100	
		S	3 48 29					
		L?	3 52 00					
		F	4 30 ca					Lost in micros.
2	....	P	8 06 40				5,500	
		PR1	8 08 37					
		S	8 13 45					
		L?	8 22 10	16				
		F	10 10 ca					
6	....	eL	17 41 00	20				
		L	17 48 ..	16				
		F	18 15 ca					Lost in micros.
7	....	S	16 29 30					
		L?	16 36 30					
		L	16 57 ..	20				
		F	18 ca					Lost in micros.
11	....	P?	14 40 30				6,500	
		S?	14 48 30					
		eL	14 59 10					
		L	15 04 15	15				
		F	16 20 ca					
11	....	P	18 56 07				8,600	
		S	19 05 57					
		eL	19 25 ..					
		L	19 40 ..	18				
		F	22 ca					Lost in micros.
13	....	P	8 46 50				4,100	
		S	8 52 45					
		eL?	8 56 30					
		L	9 03 ..	15				
		F	10 10 ca					
14	....	P?	7 10 41				8,600	
		S	7 20 30					
		eL	7 36 30					
		L	7 45 ..	22				
		L	7 52 ..	18				
		F	9 20 ca					
15	....	P	20 49 58				9,500	
		PR1	20 54 00					
		PR2	20 56 05					
		S	21 00 09					
		eL?	21 17 30	25				
		L	21 40 ..	15				
		F	23 10 ca					

TABLE 2.—*Instrumental Seismological Reports, November, 1921*—Continued.

MARYLAND. *U. S. C. & G. S. Magnetic Observatory, Cheltenham.*

1921.			H. m. s.	Sec.	μ	μ	Km.	
Nov. 11		$PR1_N$	18 57 39	3			12,800	
		S_N	19 07 27	11				
		e_E	19 15 20					
		e_E	19 20 09					
		L_N	19 34 09	22				
		M_E	20 00 40	18	20			
		M_N	20 08 37	16		20		
		F_E	20 31 ..					
		F_N	20 33 ..					
13		P_N	8 47 36	3			2,700-3,000	
		S_E	8 52 15					
		S_N	8 51 55	9				
		L_E	8 54 54					
		L_N	8 53 53	10				
		M_E	8 55 37	21	30			
		M_N	8 54 07	10		10		
		F_E	9 08 ..					
		F_N	9 15 ..					
15		P_N	20 49 50	3				No definite phases on E.
		e_N	20 53 00					
		e_E	20 59 04					
		L_E	21 02 38					
		L_N	21 00 06					
		L_N	21 03 39					
		M_N	21 03 50	12		20		
		F_E	21 38 ..					
		F_N	21 40 ..					

MISSOURI. *St. Louis Observatory, St. Louis.*

1921.			H. m. s.	Sec.	μ	μ	Km.	
Nov. 11		iP_E	18 55 48					
		S_E?	18 58 54					
		L	19 00 30	2	*1,000			Merges into next distrubance.
11		P	19 53 42					S and L tangled with L of preceding quake.
		F	20 17 ..					
13		eP_E	8 48 42				2,900	
		eS_E	8 53 18					
		L_E	8 55 00					
		M_E	8 58 42	18	*5,000			
		M_N	9 00 30	12		*4,000		
		F	9 04 00					
15		eP_E	20 52 54				6,100	
		iS_E	21 00 36					
		L_E	21 08 42					
		M_E	21 22 48	30	*3,000			
		M_N	21 23 30	30		$3,000		
		F	21 44 ..					

* Trace amplitude.

CANAL ZONE. *Panama Canal, Balboa Heights.*

1921.			H. m. s.	Sec.	μ	μ	Km.	
Nov. 2								Slight tremor between 7:00 and 9:00.
11								Slight tremors between 18:56 and 21:00.
13		P_E	8 43 00				885 ca.	Direction NW?
		P_N	8,42 58					
		S_E	8 44 36					
		S_N	8 44 34					
		L_E	8 46 12					
		L_N	8 46 10					
		M_E	8 46 36		*1,000			
		M_N	8 46 58			*1,500		
		F_E	9 03 00					
		F_N	9 05 00					
27		P_E	7 55 40				113 ca.	Direction SW?
		P_N	7 55 41					
		S_E	7 55 53					
		S_N	7 55 54					
		M_E	7 55 55		*800			
		M_N	7 55 56			*1,000		

* Trace amplitude.

PORTO RICO. *U. S. C. & G. S. Magnetic Observatory, Vieques.*

1921.			H. m. s.	Sec.	μ	μ	Km.	
Nov. 11		e_E	19 25 00	24				All of N and part of E obscured by wind tremors.
		e_N	19 58 16	25				
		M_E	20 15 06	23	20			
		C_E	20 25 ..	25				
		F_E	20 39 ..					
13		e_E	8 46 02	2				
		e_N	8 46 15	2				
		L_E	8 48 42	22				
		L_N	8 48 54	20				
		M_E	8 49 22	22	20			
		M_N	8 49 01	20		10		
		C_E	8 51 ..	13				
		C_N	8 58 ..	10				
		F_E	9 10 ..	9				
		F_N	9 06 ..					

VERMONT. *U. S. Weather Bureau, Northfield.*

1921.			H. m. s.	Sec.	μ	μ	Km.
Nov. 11		e	19 14 ..				
		L	19 56 ..	20			
		F	20 15 ..				

CANADA. *Dominion Observatory, Ottawa.*

1921.			H. m. s.	Sec.	μ	μ	Km.	
Nov. 2		e_E	3 59 ..					
		e_E	4 01 56					
		F	4 15 ..					
2		$e?_E$	8 07 30					
		e_E	8 15 04					
		eL_E	8 20 40					
		L_E	8 24 ..	35				
		L_E	8 32 ..	17				
		i_E	8 40 11					Probably a second quake, but not differentiated sufficiently for separate reading.
		L_E	8 49 30	30				
		L_E	9 00 ..	17				
		F	Micros.					
6		eL_E	17 53 ..					
		L_E	17 55 ..	17				
		F	18 04 ..					
7		$eL?_E$	16 56 30					
		L_E	16 59 ..	35				
		L_E	17 04 ..	26				
		L_E	17 09 ..	25				
		L_E	17 13 ..	21				
		F	17 30 ..					
11		eL_E	(15 02)					Micros on NS.
		L_E	15 03 ..	22				
		L_E	15 09 ..	16				
		F	15 35 ..					
11		O	(18 45)				(8,800)	
		P	18 56 58					
		S	(19 07)					
		$SR1_E$	19 13 30					
		eL	19 27 ..					
		L	19 42 ..	27				
		L	19 51 ..	20				
		i	19 55 35					
		L_E	20 00 ..	22				
		L	20 03 ..	17				
		L	20 10 ..	19				
		L	20 20 ..	17				
		F	21 30 ..					
13		e_E	8 53 08					
		eL_E	8 55 26					
		L_E	9 00 ..	20				
		L_E	9 07 ..	16				
		F	9 35 ..					
15		P	20 49 32				9.010	*O* at 20 : 37 : 17.
		PR1	20 53 02					
		$PR2_E$	(20 55 12)					
		S	20 59 41					
		$SR1_E$	(21 05 53)					
		$SR2_E$	(21 09 32)					
		eL_E	21 18 ..					
		L	21 20 ..	16				
		L	21 30 ..	12				
		F	22 20 ..					

TABLE 2.—*Instrumental Seismological Reports, November, 1921*—Continued.

CANADA. *Dominion Meteorological Service, Toronto.*

1921.		H. m. s.	Sec.	μ.	μ.	Km.	
Nov. 2	iL	4 01 06					
	M	4 04 18		*300			
	F	4 15 54					
2	e	8 15 18					Quake reported from Peru. Record suggests dual shock.
	e	8 20 54					
	eL	8 26 00					
	M	8 28 36		*300			
	eL	8 40 36					
	eL	8 49 12					
	eL	8 58 54					
	F	9 17 12					
6							Small quake lost attending to instrument.
7	e	16 26 48					
	e	16 33 06					
	eL	17 04 18					
	eL	17 05 48					
	eL	17 19 42					
	eL	17 30 30					
	M	17 32 30		*300			
	eL?	18 40 18					
	F	18 46 54					
11	eL	15 04 30					
	L	15 06 42					
	eL	15 14 18		*200			
	F	15 35 24					
11	P?	18 50 18					
	PR?	18 54 48					
	iS	18 59 36					
	eL	19 25 24					
	L	19 36 54					
	eL	19 39 00					
	eL	19 51 36					
	eL	20 02 18					
	M	20 07 48		*1,200			
	M	20 10 12					
	L	20 20 12					
	eL	20 48 18					
	iL	21 02 18					
	F	21 32 54					
13	iL	8 56 18					
	eL	8 57 48					
	eL	9 00 18					
	M	9 01 18		*400			
	F	9 20 48					
14	eL	7 54 54					Very gradual increasing vibrations; distant.
	M	8 02 30		*500			
	F	8 09 48					
15	S	21 00 00					Appearance somewhat similar to continuous local shocks.
	iSR1	21 02 30					
	iSR2	21 07 48					
	e	21 13 00					
	?iSR3	21 15 00					
	iL	21 19 42					
	M	21 22 54		*1,000			
	eL	21 31 00					
	eL	22 01 00					
	eL	22 08 12					
	F	22 32 18					
24	eL?	11 32 18?					
	M?	11 33 06?		*200			
	F						Micros.
29	eL	23 43 24					
	M	23 47 48		*200			
	F	0 08 06					

CANADA. *Dominion Meteorological Service, Victoria.*

1921.		H. m. s.	Sec.	μ	μ	Km.
Nov. 2	L	3 06 58				
	M	3 11 24		*200		
	F	3 18 17				
2	L	3 55 09				
	M	4 02 03		*800		
	F	4 18 46				
2	S?	8 16 47				
	L	8 24 39				
	M	8 40 53		*500		
	F	9 29 34				
6	L	17 17 49				
	M	17 35 02		*200		
	F	17 57 39				
7	P	16 12 56				6,310?
	S	16 20 49				
	L	16 30 38				
	M	16 50 48		*1,000		
	F	18 40 28				
11	L	14 45 34				
	M	14 53 56		*150		
	F	15 14 06				
11	S	18 49 01				
	L	19 00 20				
	M	19 26 53		*2,000		
	F	21 49 01				
		VERTICAL.				
	S	*18 50 00*				
	M	*19 17 30*	*25*	*3*		
13	?P	8 58 31				
	?L	9 02 28				
	L	9 10 50				
	M	9 21 40		*500		
	F	9 52 08				
14	L	7 16 11				
	M	7 35 50		*450		
	F	7 49 45				
15	P?	20 50 53				
	S	20 59 45				
	iSR?	21 01 27		*700		
	eL	21 20 33				
	M	21 22 12		*1,000		
	F	22 58 18				
17	L	8 35 13				
	M	8 43 05		*200		
	F	8 55 53				
24	M	11 16 22		*100		
	F	11 18 20				
29	L	23 23 35				
	M	23 26 02		*200		
	F	23 36 51				

*Trace amplitude.

No earthquakes were recorded at the following stations during November, 1921:

COLORADO. *Regis College*, Denver.

NEW YORK. *Fordham University*, New York.

Reports for November, 1921, have not been received from the following stations:

ALABAMA. *Spring Hill College*, Mobile.

CALIFORNIA. *Theosophical University*, Point Loma.

HAWAII. *U. S. C. & G. S. Magnetic Observatory*, Honolulu.

MASSACHUSETTS. *Harvard University*, Cambridge.

NEW YORK. *Canisius College*, Buffalo; *Cornell University*, Ithaca.

Chart I. Hydrographs of Several Principal Rivers, November, 1921.

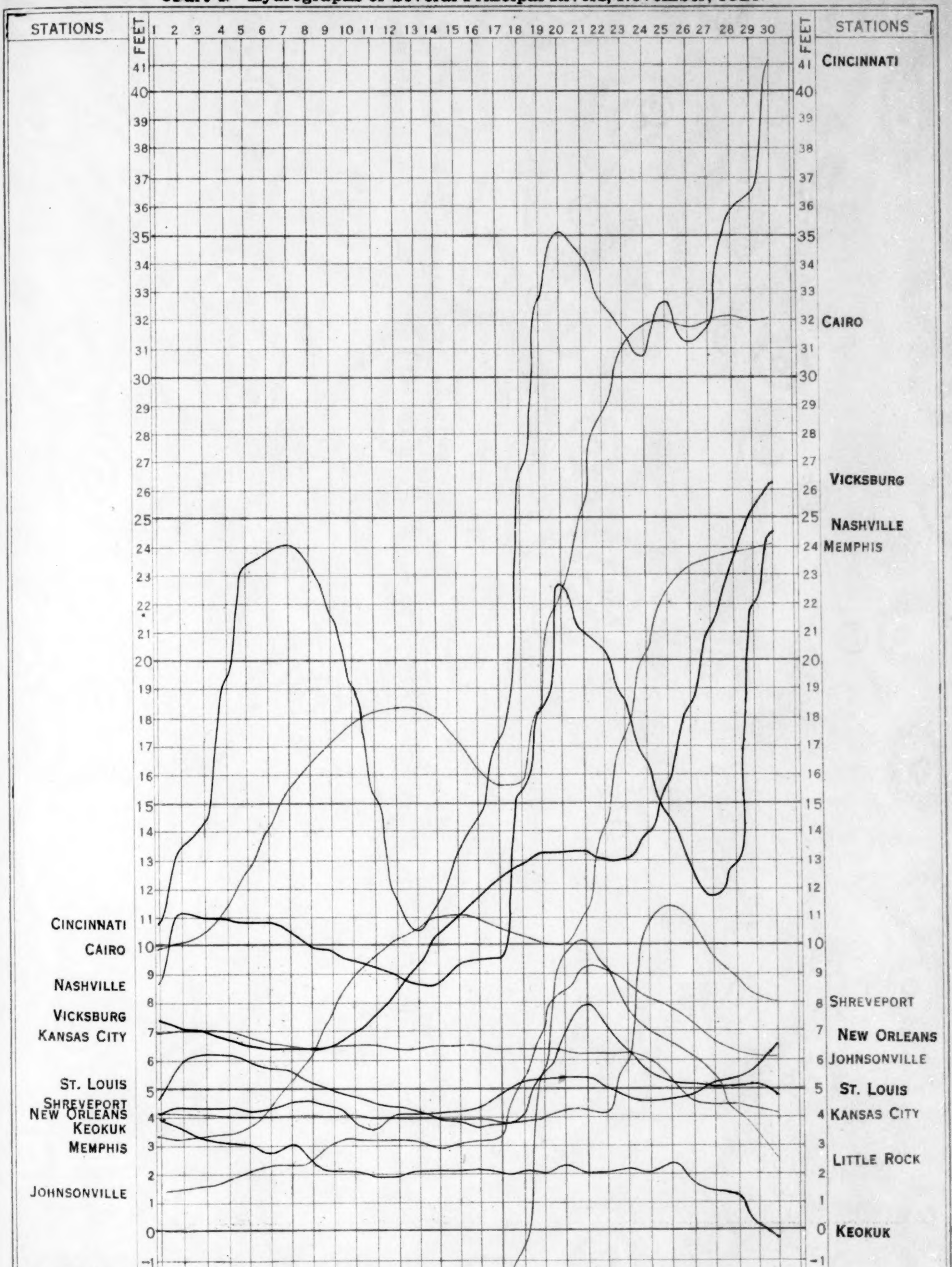


Chart II. Tracks of Centers of High Areas, November, 1921.
(Plotted by Wilfred P. Day.)

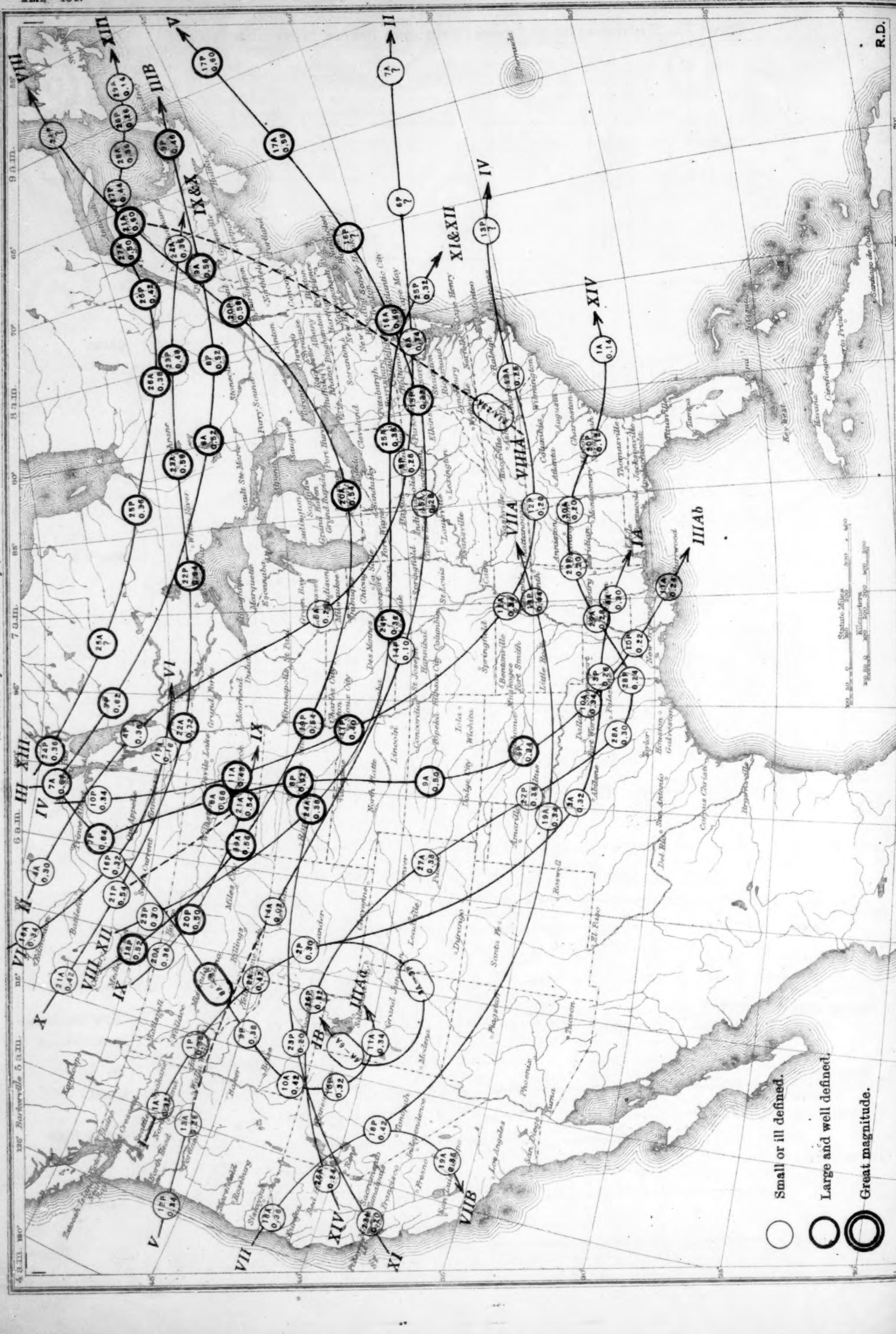
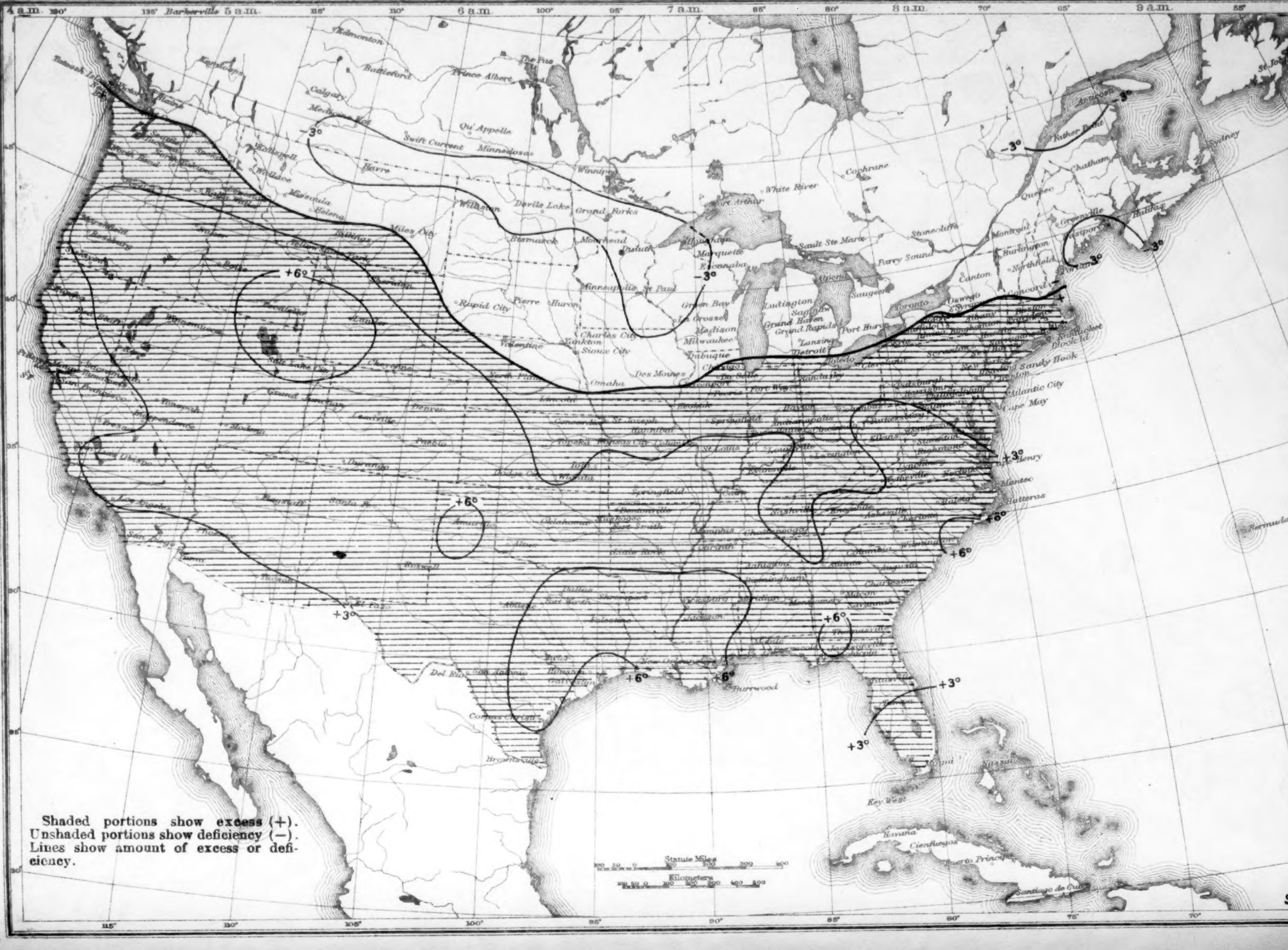


Chart III. Tracks of Centers of Low Areas, November, 1921.

Chart III. Tracks of Centers of Low Areas, November, 1921.

(Plotted by Wilfred P. Day.)

Chart IV. Departure (°F.) of the Mean Temperature from the Normal, November, 1921.



Shaded portions show excess (+).
Unshaded portions show deficiency (—).
Lines show amount of excess or deficiency.

Chart V. Total Precipitation, Inches, November, 1921.

Chart VI. Percentage of Clear Sky between Sunrise and Sunset, November, 1921.

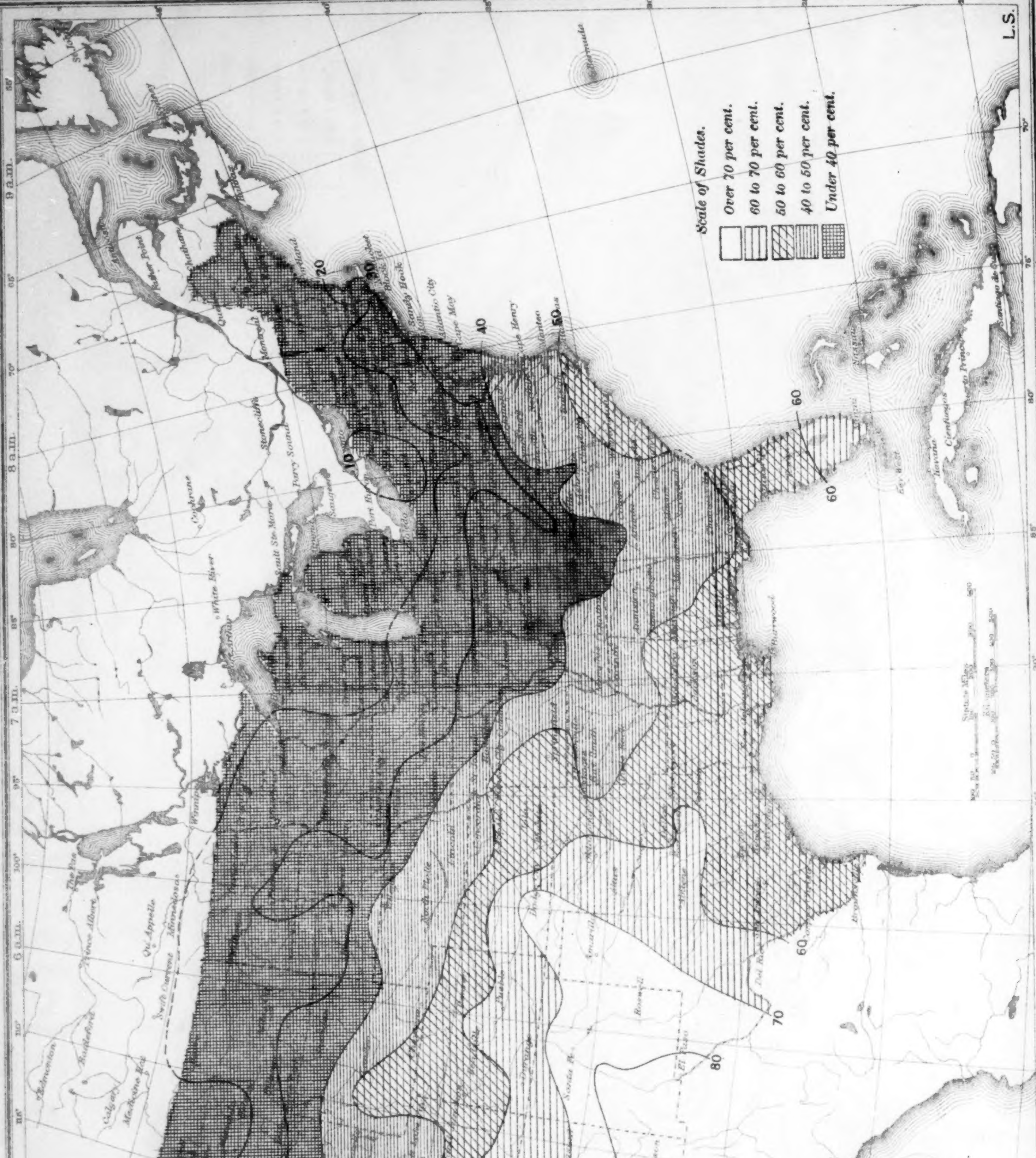


Chart VII. Isobars at Sea-level and Isotherms at Surface; Prevailing Winds, November, 1921.

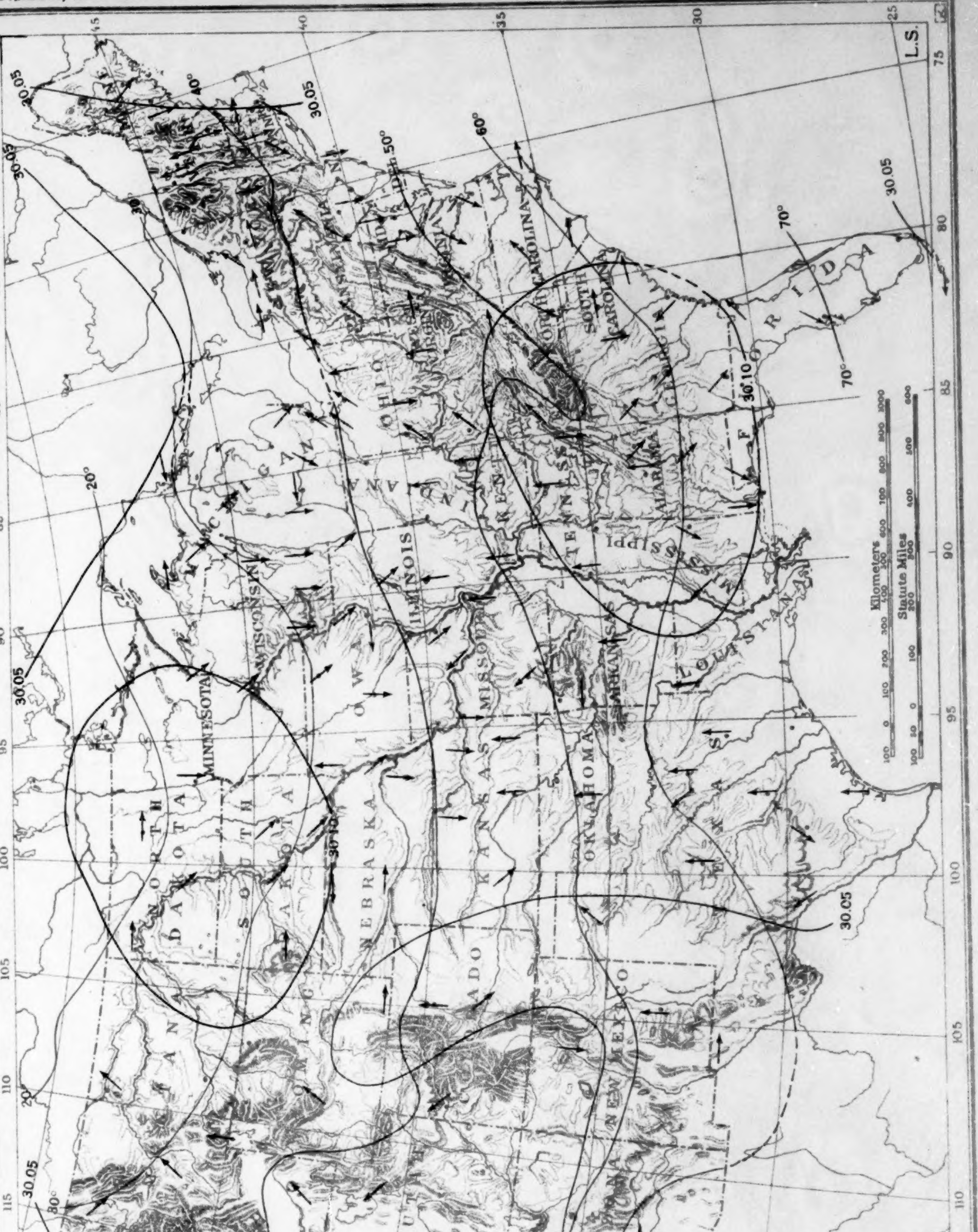


Chart VIII. Total Snowfall, Inches, November, 1921.

Chart IX. Weather Map of North Atlantic Ocean, November 14, 1921.

Chart IX. Weather Map of North Atlantic Ocean, November 14, 1921.

(Plotted by F. A. Young.)

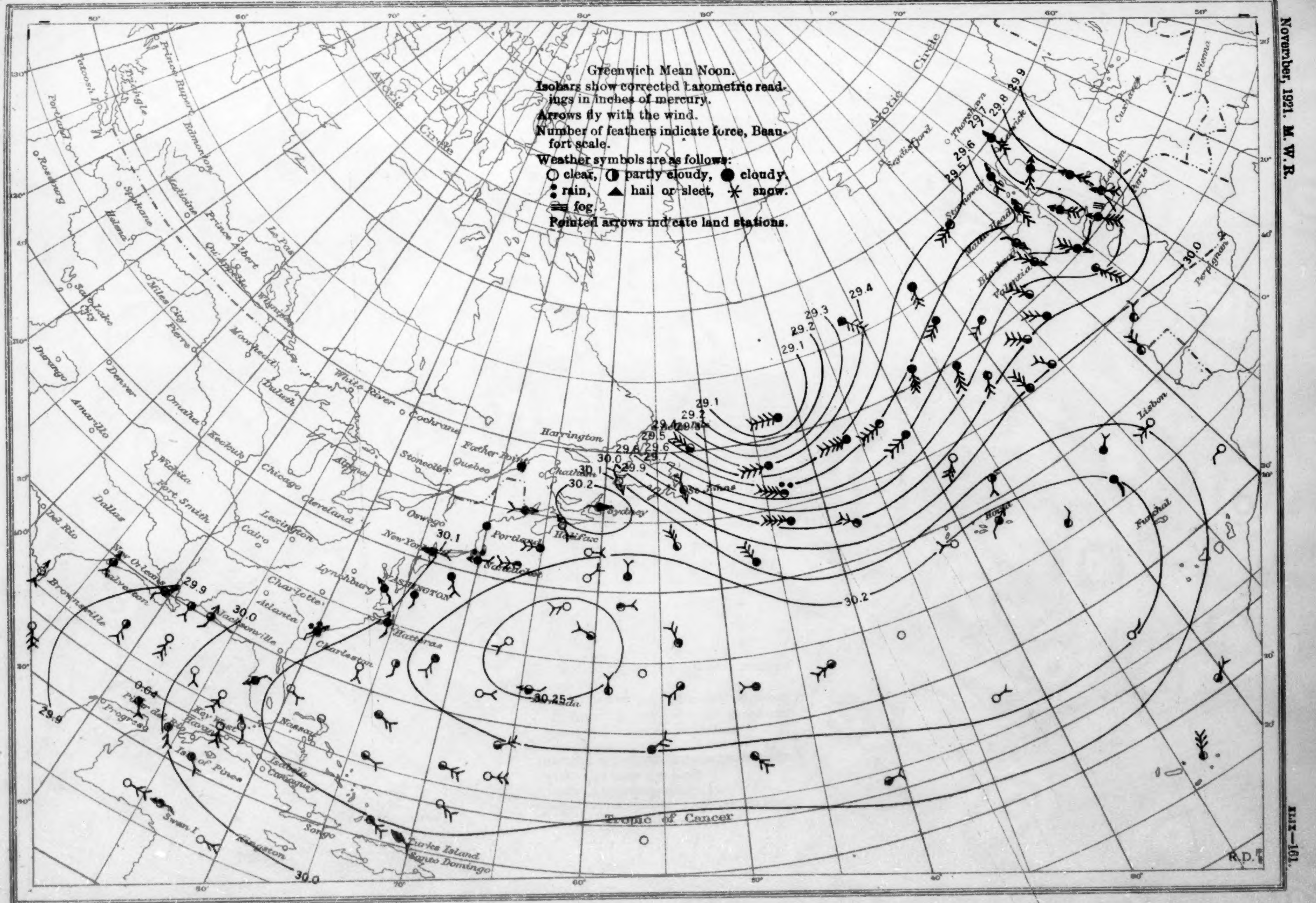


Chart X. Weather Map of North Atlantic Ocean, November 15, 1921.
(Plotted by F. A. Young.)

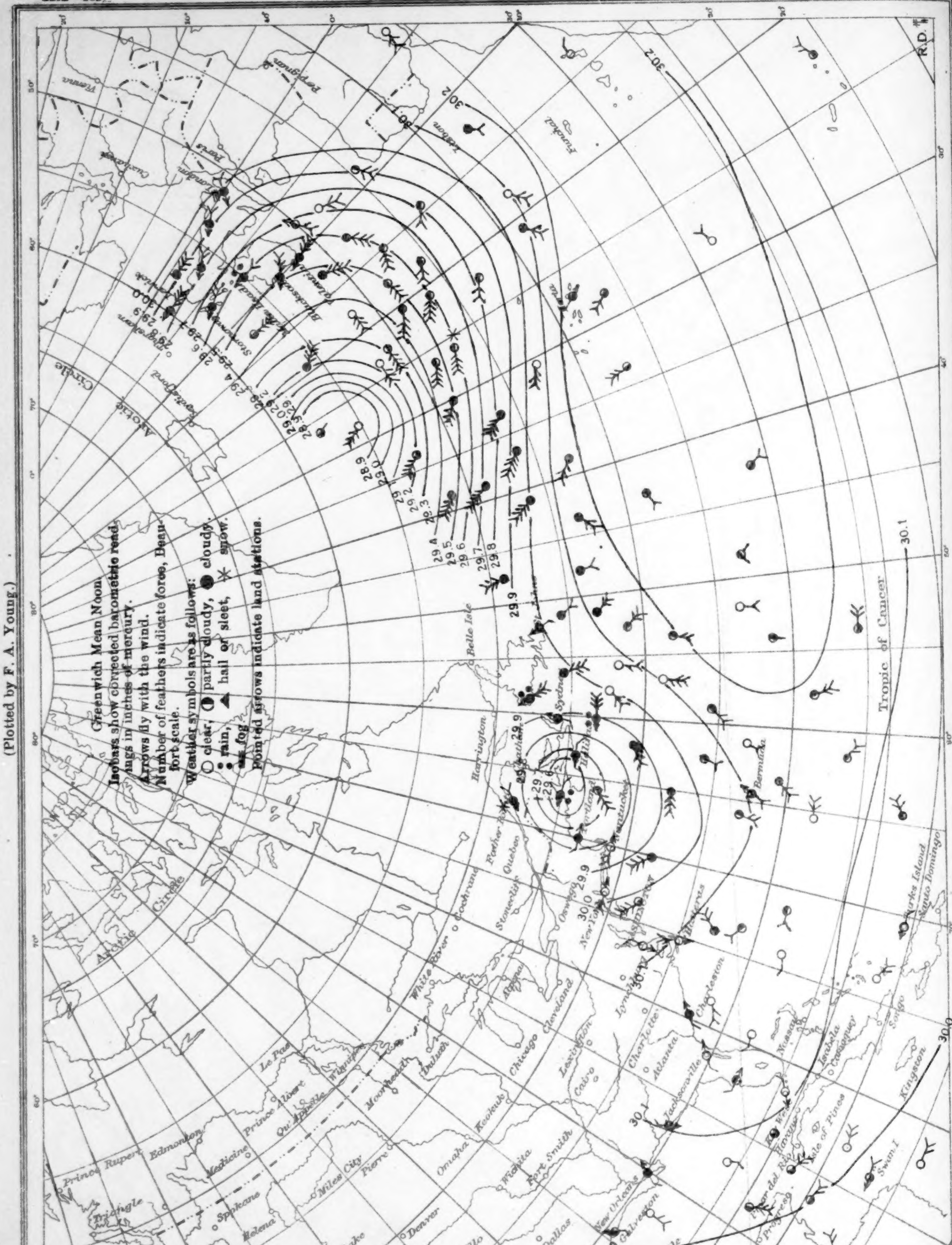


Chart XI. Weather Map of North Atlantic Ocean, November 16, 1921.

Chart XI. Weather Map of North Atlantic Ocean, November 16, 1921.

(Plotted by F. A. Young.)

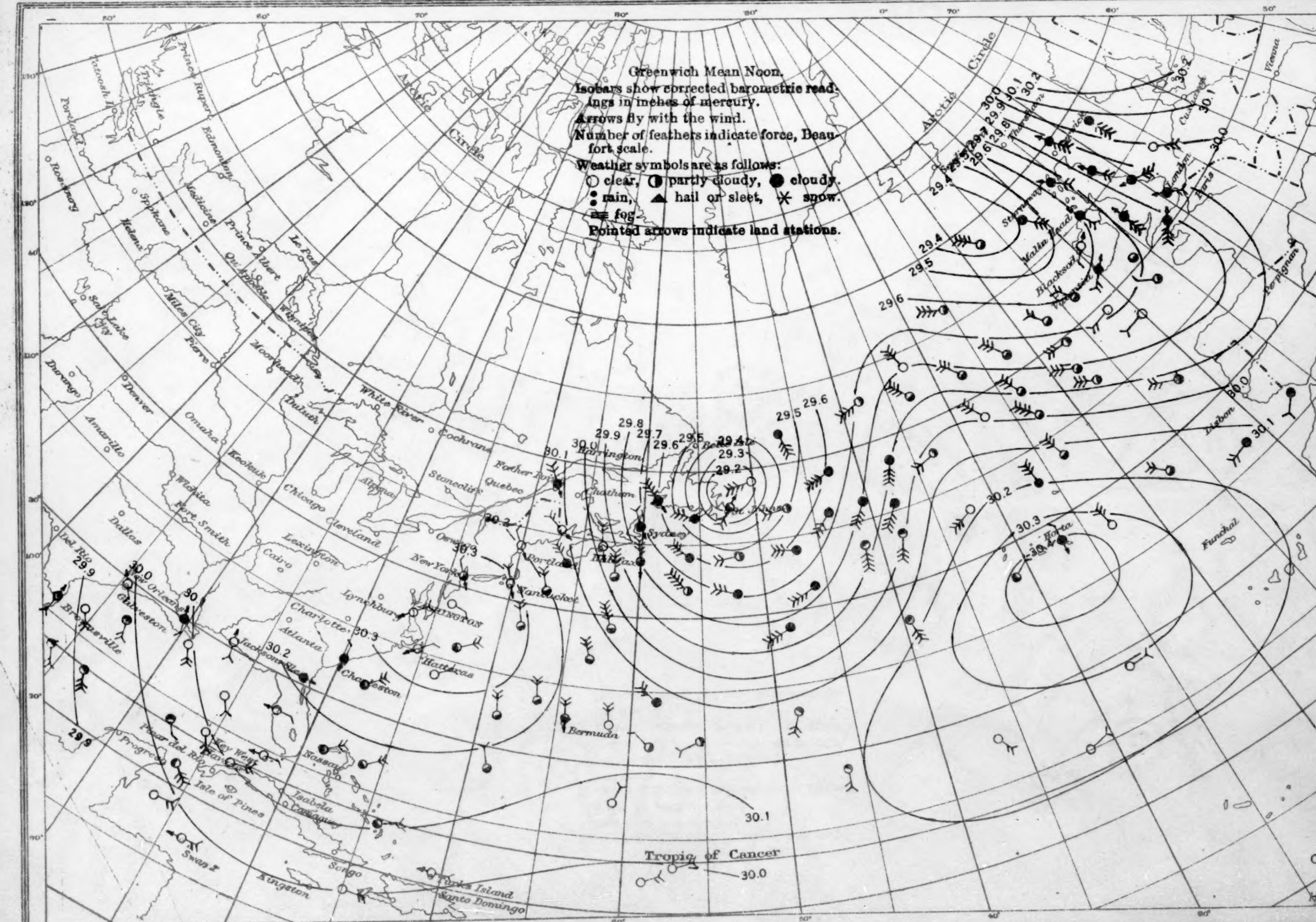
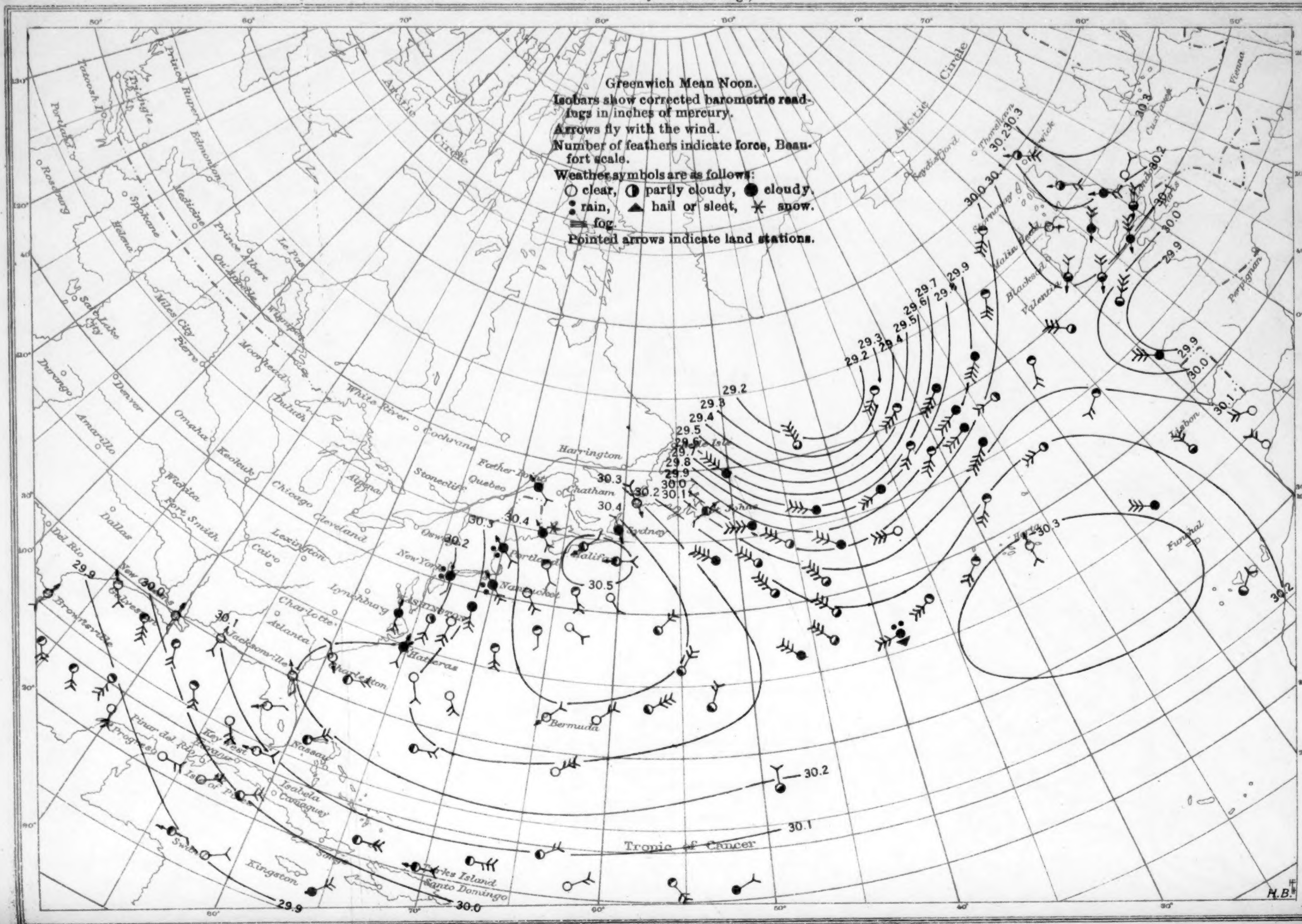


Chart XII. Weather Map of North Atlantic Ocean, November 17, 1921.

(Plotted by F. A. Young.)



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NOVEMBER, 1921.

CONTENTS.

CORRIGENDA.

REVIEW, July, 1921:
- Pages 390-391, the author's initials *should read* "L. C. W".
- Page 390, 2nd column, in the title of the article, *change* "Element" *to* "Elements and".
- Page 390, 2nd column, 18th line from bottom, *change* "phases or" *to* "phases of".

REVIEW, July, 1921—Continued.
- Page 392, 2nd column, 26th line from top, *omit* "of" *after word* "because".
- Page 392, 2nd column, 35th line from top, *for* "activities" *read* "activity".
- Page 393, 2nd column, 7th line from end of article, "conventional" *should read* "convectional".

† In marine separate.